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COVER

Tellervo zoilus (Fabricius), mating in rainforest understory at Mission Beach, northern Queensland. This species is one of a handful of true understory dwelling butterflies in Australia. Males form leks, mating dances of several individuals, in sunny patches in the morning. Females approach, then are led by a male to the underside of a nearby leaf where copulation ensues. Sometimes the female leads and initiates genital contact. As in many butterflies, the male, right, enters a catatonic state during ejaculation. Pen and ink drawing by Caloundra ESQ member, Dr Albert Orr, whose illustrated books on butterflies and dragonflies have won awards in Australia and overseas. His second book on New Guinea Odonata has just appeared (see *Australian Entomologist* **43** (1): 38).

REVIEW OF THE AUSTRALIAN SPECIES OF *ARCTORNIS* GERMAR, 1810 (LEPIDOPTERA: EREBIDAE: LYMANTRIINAE)

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Abstract

Four new species of *Arctornis* Germar, 1810 are described and illustrated from Australia: *Arctornis queenslandica* **sp. n.**, *Arctornis lucens* **sp. n.**, *Arctornis ravenshoeae* **sp. n.**, *Arctornis cairnsae* **sp. n.** and *Arctornis commoni* **sp. n.** All are confined to northeastern Queensland.

Introduction

The genus *Arctornis* Germar, 1810 is widely distributed throughout the Oriental tropics, Sundaland and New Guinea and also extends into the Palaearctic region. It is extremely diverse and, as currently defined, probably includes at least 200 species. Only in Borneo has a major part of the fauna been revised (Holloway 1999). The genus has long been recognised as being represented in Australia (as *Redoa* Walker, 1855), with the first recorded species wrongly identified as the Oriental *Arctornis submarginata* Walker, 1855 (Turner 1921). The Australian checklist of Lepidoptera dealt with the issue of *A. submarginata* and listed one undescribed species (Edwards 1996). In his review of the Bornean species, Holloway (1999) provided the current interpretation of *Arctornis* and broadly defined the genus on the basis of the male genitalia: the harpe is well developed and arises from the sacculus and the aedeagus is short and usually has a pair of finger-like processes developed on the rim of its orifice. Tymbals are present in the abdomen of the male. Adults are frequently very similar in general facies, being satiny white, sometimes with a small black discal spot. Correct determination usually requires examination of the genitalia. This similarity also makes it difficult to associate males with females.

In the material examined for this present study, several specimens bear labels indicating that they had been barcoded. Sexes were associated in three species by use of this barcoding, which was based on similarity of COI sequences. Details of analyses, sequence data, geographical and ecological data are available through the Barcode of Life Data System (BOLD: Ratnasingham and Hebert 2007) and BOLD process ID's are given for the relevant specimens under material examined. In the descriptions below, both sexes are similar unless otherwise indicated, while forewing length is the distance from the base of the wing at its articulation to the tip of the apex. The known Australian fauna comprises five species, which are described and illustrated below.

Abbreviations: AM – Australian Museum, Sydney; ANIC – Australian National Insect Collection, Canberra; APM – collection of A.P. Mackey, Yandina; UQIC – University of Queensland Insect Collection (housed at the Queensland Museum); QM – Queensland Museum, Brisbane.

Arctornis Germar, 1810

Cassidia Walker, 1862
Chatracharta Walker, 1862
Ciaca Walker, 1865
Cobanilla Moore, [1883] 1882-3
Kanchia Moore, [1883] 1882-3
Lymantralex Collenette, 1938
Redoa Walker, 1855
Scarpona Walker, 1862
Topomesa Walker, 1866

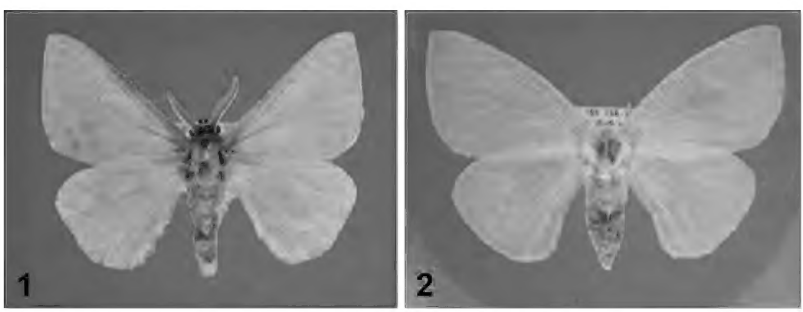
Type species: *Arctornis l-nigrum* (Müller, 1764).

Arctornis queenslandica sp. n.

(Figs 1-7)

Types. Holotype ♂, QUEENSLAND: 14 km W by N of Hope Vale Mission, 8.x.1980, E.D. Edwards, ANIC Genitalia Slide no. 19839, in ANIC. *Paratypes*: 1 ♀, 14 km W by N of Hope Vale Mission, 8.x.1980, E.D. Edwards, ANIC Genitalia Slide no. 19838, in ANIC; 1 ♂, Kuranda, 1-15.ii.2008, D.C.F. Rentz, ANIC Genitalia Slide no. 19846, in ANIC; 1 ♀, Hervey's Range, 8.xi.2006, G. Cocks, G290, DNA Barcode LOQT506-06, gvc6341, in APM.

Additional material examined. QUEENSLAND: 2 ♂♂, Hervey's Range, June 2006 & 26.iv.2007, G. Cocks, DNA Barcodes: LOQT380-06, gvc5833-1L and LOQTB344-07, gvc7087-1L respectively, in APM; 1 ♂, 1 ♀, Hervey's Range, 1.v. 2009, G. Cocks, in APM; 2 ♂♂, Cairns, 8.i.1987 & 1.i.1989, A.P. Mackey, in APM; 1 ♂, West Claudie River, 4 km SW of road junction, 1.xii.1986, G. Daniels & M. Schneider, in UQIC.



Figs 1-2. *Arctornis queenslandica* sp. n: (1) Holotype male, Hope Vale Mission, Qld; (2) Paratype female, Hope Vale Mission, Qld.

Description (Figs 1-2). Head lightly scaled, white, with pair of purplish brown dots between eyes just below antennal bases; pair of thin purplish brown bars between antennal bases which extend almost to mid-line; labial palp upturned, white, with purplish brown tip; antennal filament with fine dusting of white scales that become worn away, pectinations pale reddish

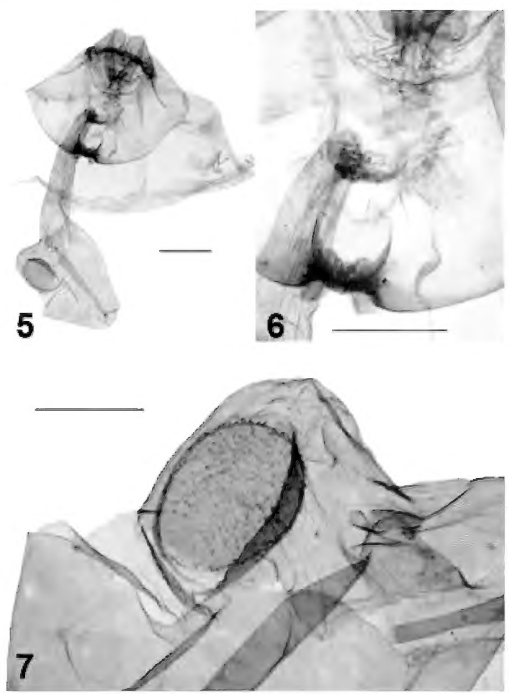
yellow, long in male but very short in female. Thorax white; legs white, pro- and mesothoracic legs with purplish brown spot towards proximal end of tibia and on first tarsal segment. A faint spot may be present on joint between femur and tibia. Abdomen lightly scaled, silvery white. Forewing length: male 18-20 mm; female 28 mm. Both forewing and hindwing lightly scaled and glistening white. Scales in central part of wings appear to be lost easily leaving transparent white wing membrane and some sparse areas of glistening scales along margins and discal vein; this effect more apparent in female where most scales are lost. Underside similar except that scales less glistening.

Figs 3-4. *Arctornis queenslandica* male genitalia: (3) ventral view, Hope Vale Mission, Qld, slide ANIC19839; (4) aedeagus, Kuranda, Qld, slide ANIC19846. Scale bars *ca* 1 mm.

Male genitalia (Figs 3-4). Tegumen and vinculum lightly sclerotised and loosely united; tegumen hood-like; vinculum a narrow U-shaped strap; saccus weak; uncus well sclerotised, short, broad, deep and bifid, slightly hooked, posterior face crenulate, punctulate and setose with long setae dorsally and laterally; valva elongate, subrectangular and with bluntly rounded apex, costa folded inwardly, sacculi large and well developed, adpressed but not fused basally, outer surface of dorso-distal part of valva bears small, triangular lobe covered with long, fine, setae, internal ventro-distal part of valva is in form of stout, downturned beak, harpe well developed and partly embedded in pouch formed between sacculus and costal fold, flat, slender, slowly tapering to fine point, about two thirds the length of the valva; juxta moderate but lightly sclerotised, slightly reflexed, strongly concave, dorsal edge emarginate in

ventral view; aedeagus short, broad and deep, weakly sclerotised except for two slender, finger-like dorso-lateral projections from the carina penis, caecum reflexed ventrally, vesica without ornamentation.

Female genitalia (Figs 5-7). Papillae anales shallowly and bluntly triangular, covered with long fine setae; apophyses posteriores slender and slightly curved and tapering, extending well into segment VIII; segment VIII broad and collar like, apophyses anteriores very short and truncate; pseudopapillae long, narrow, tapering slightly from posterior to anterior, setose; lamella postvaginalis almost membranous, crescent-shaped, bearing a series of long setae along its posterior edge; the deep channel-shaped sinus vaginalis occupies most of the medial area of sternite VIII, the lamella antevaginalis forms a small cup at its anterior part and at the bottom of the cup is a complex of sclerotised folds; the opening of the ostium bursa is situated at the end of the channel and broadens toward thin-walled sac of corpus bursae; signum large and ovate, covered with rugged, short, stout spines.



Figs 5-7. *Arctornis queenslandica* female genitalia, Hervey's Range, Qld, slide G290: (5) overview; (6) sterigma; (7) signum. Scale bars *ca* 1 mm (5-6) or 0.5 mm (7).

Diagnosis. This is the largest of the Australian *Arctornis* species and the only one with the satiny, translucent sheen to the wings. The male and female genitalia are distinctive and unlike any other Australian species.

Etymology. queenslandica (Latin adjective) – pertaining to Queensland.

Distribution. North Queensland: coastal ranges from Townsville north to Iron Range in Cape York Peninsula.

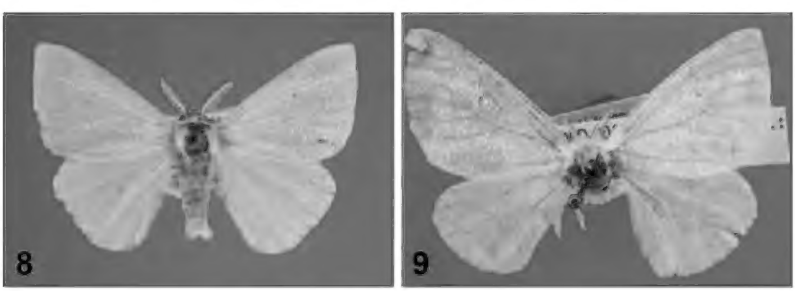
Remarks. Sexes, originally associated by size, were confirmed to be conspecific by barcoding. Specimens in collections often show pale cream discolouration along the forewing costa, at the vein bases and on the thorax and abdomen, but these marks are not found on freshly caught material. This species is similar to *Arctornis perfecta* (Walker, 1862) from Sundaland and Sulawesi, but in *A. perfecta* the harpe is much longer, extending well beyond the end of the valve, and in the female the lamella postvaginalis has a large medial lobe on the anterior margin (Holloway 1999: figs 354, 378).

Arctornis lucens sp. n.

(Figs 8-14)

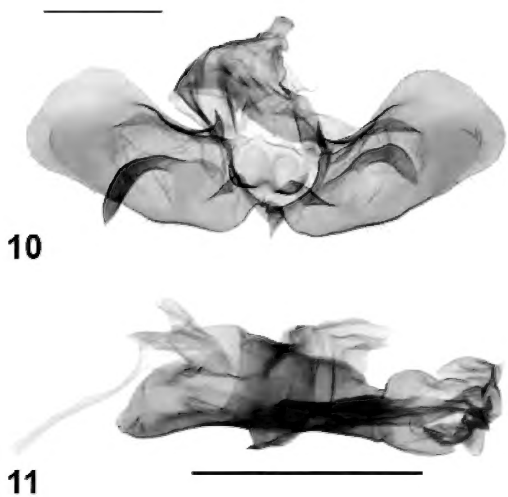
Types. Holotype ♂, QUEENSLAND: Mission Beach near Tully, 30.x.1967. R. Dobson, ANIC Genitalia Slide no. 19834, in ANIC. *Paratypes*: 1 ♀, Cairns, 1-20.vii.2005, P. Hebert, G336, DNA Barcode: LOQC411-05, 05-QLD-00411; 1 ♂, Kuranda, 1-15.xii.2005, D.C.F. Rentz. ANIC Genitalia Slide no. 19833, ANIC DNA no. 000971, in ANIC.

Additional material examined. QUEENSLAND: 1 ♂, Kuranda, 16-31.xii.2005, D.C.F. Rentz. ANIC DNA no. 000970; 1 ♂, 1 km SE of Mt. Cook, Cooktown, 13.x.1980, E.D. Edwards, ANIC Genitalia Slide no. 19836; 1 ♂, Mt. Webb National Park, 50 km N. Cooktown, 11-14.vii.1976, G.B. & S.R. Monteith, ANIC Genitalia Slide no. 19842, all in ANIC; 1 ♂, Barrine, April 1948, K469601, in AM; 3 ♂♂, Kuranda, 1.iv.1928, 3.iv.1928 & 1.iv.1928, G143, G144 & G150, all in UQIC.



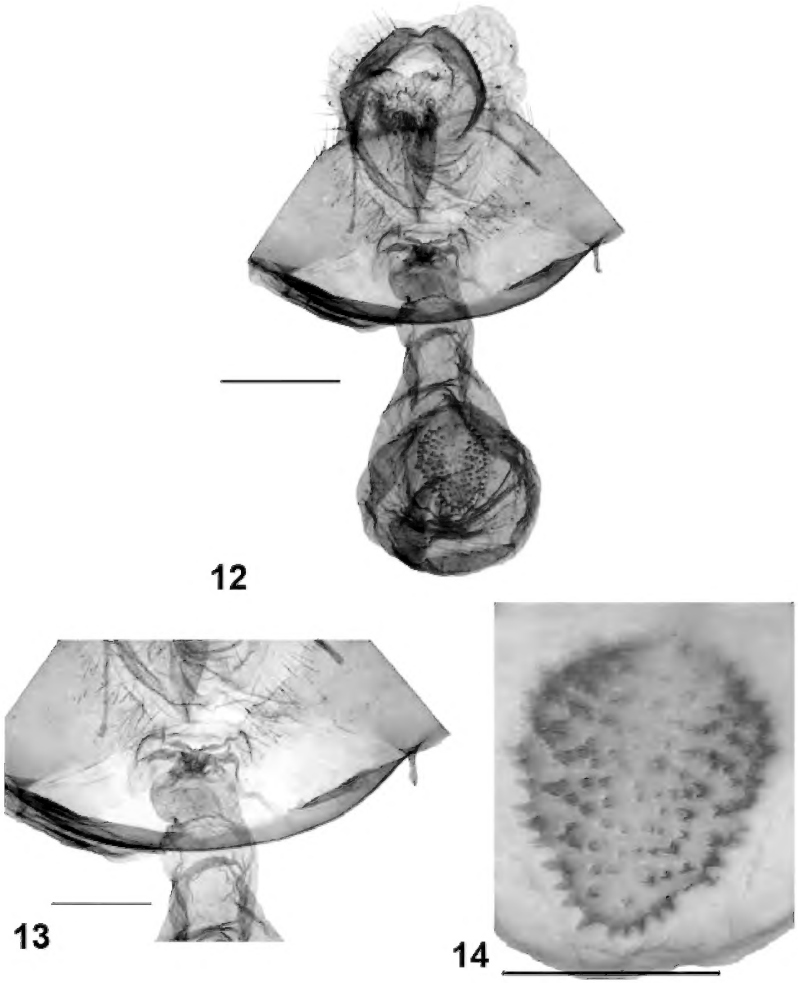
Figs 8-9. *Arctornis lucens* sp. n: (8) Holotype male, Mission Beach, Qld: (9) Paratype female, Cairns, Qld.

Description (Figs 8-9). Head white, frons lightly speckled with brownish orange, vertex brownish orange; labial palp upturned, brownish orange; antennal scape brownish orange ventrally and laterally, white dorsally, filament white, pectinations long in male, shorter in female, pale brownish yellow. Thorax moderately scaled, white; legs white, fore and mid tibia with large purplish brown spot sometimes with brownish orange edges proximally, all legs with purplish brown spot on first tarsal segment and brownish orange fifth tarsal segment. Abdomen lightly scaled, silvery white. Forewing length: male 15-16 mm; female 19 mm. Both forewing and hindwing glistening white, forewing with coruscations caused by irregular longitudinal ridges of scales, hindwing less glistening particularly within discal region; forewing with minute black discal spot at inflection of r-m; termen of fore- and hindwing with faint greyish tinge especially towards the middle. Underside of both wings milky white.



Figs 10-11. *Arctornis lucens* male genitalia, Mission Beach, Qld, slide ANIC19834: (10) ventral view; (11) aedeagus. Scale bars *ca* 1 mm.

Male genitalia (Figs 10-11). Tegumen and vinculum united; tegumen hood-like, narrowing considerably laterally to join very narrow vinculum, which widens ventrally; saccus weak; uncus short, broad, slightly hooked, shoulders broad, dorsally towards base a small patch of long fine setae either side of mid-line, a ventral, membranous transverse ridge extending as lobe on each side of uncus and bearing long fine setae may represent socii; valva lightly sclerotised, broad, elongate, subrectangular, broadening slightly distally,



Figs 12-14. *Arctornis lucens* female genitalia, Cairns, Qld, slide G336: (12) overview; (13) sterigma; (14) signum. Scale bars *ca* 1 mm (12, 14) or 0.5 mm (13).

sacculi well developed, harpe moderate, well sclerotised, tubular, tapering to blunt point, strongly reflexed ventrally, distal half bearing rows of small spines; annellus lightly sclerotised; juxta lightly sclerotised, r-shaped in lateral view, subrectangular plate in ventral view, longer sides emarginate; aedeagus short, broad and deep, lightly sclerotised except for two well

sclerotised, dorso-lateral finger-like lobes arising from the carina penis, coecum relatively long, reflexed ventrally, vesica without ornamentation.

Female genitalia (Figs 12-14). Papillae anales short, broad, rounded and rather narrow in terminal view, covered with long setae, apophyses posteriores moderate, projecting about half way into segment VIII, ribbon-like, truncate; segment VIII a broad collar, zone of long setae around the posterior margin, mid-ventrally a short broad channel extending about half way across sternite marking opening of sinus vaginalis, lamella antevaginalis a simple lip at anterior end of channel, lamella postvaginalis at posterior end of the channel very lightly sclerotised, rectangular with poorly defined transverse median ridge, apophyses anteriores ribbon-like, very short; pseudopapillae well developed, elongate; an almost membranous, narrowly crescentic sclerite bearing some long setae present intersegmentally between segments VIII and the ovipositor lobes; ostium bursae opening directly behind lip of lamella antevaginalis; ductus bursae very short, membranous, leading into neck of pyriform corpus bursae; signum large, inverted leaf-shaped covered with rugged, short, stout spines, smaller towards a longitudinal, medial area.

Diagnosis. This is the only Australian species in which males have a robust and strongly reflexed harpe. Females can be distinguished by the rugged spines of the signum.

Etymology. lucens (Latin adjective) – shining.

Distribution. North Queensland: coastal areas from Mission Beach north to Mt Webb.

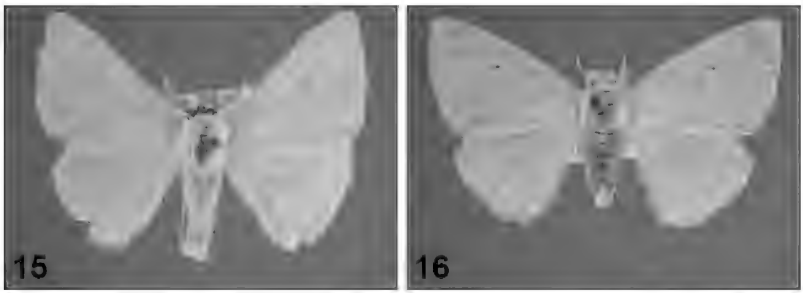
Remarks. This is the most commonly collected Australian *Arctornis* species and is likely to be more widely distributed than recorded here. Males and females were associated by barcoding.

***Arctornis ravenshoeae* sp. n.**

(Figs 15-21)

Types. Holotype ♂, QUEENSLAND: 9 miles SSE of Ravenshoe, 21.iv.1969, I.F.B. Common & M. Upton, 2750 ft, ANIC Genitalia Slide no. 19835, in ANIC. *Paratypes*: 1 ♀, Kuranda, 1-15.iv.2005, D.C.F. Rentz, ANIC Genitalia Slide no. 19832, ANIC DNA no. 000698; 1 ♀, Mission Beach nr. Tully, 24-28.1967, R. Dobson, ANIC Genitalia Slide no. 19841; 1 ♂ Cooper's Creek, 26.viii.2003, P.D.N. Hebert, G541, DNA Barcode: LOQB517-05, Moth 210.03CC, all in ANIC.

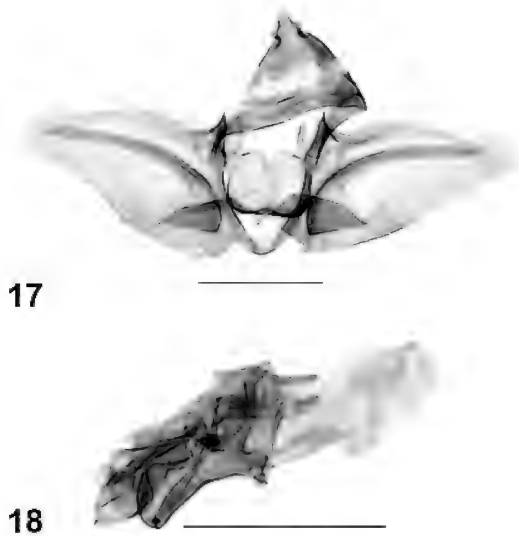
Additional material examined. QUEENSLAND: 1 ♂, 4 mls W of Babinda, 10.iii.1964, I.F.B. Common & M. Upton; 1 ♂, Kuranda, 15-30.vi.2004, D.C.F. Rentz, ANIC Genitalia Slide no. 19843; 1 ♂, Kuranda, 1-15.vii.2005, D.C.F. Rentz, ANIC Genitalia Slide no. 19845; 1 ♂, Lizard Island, 1.v.2001, P.D.N. Hebert, G333, DNA Barcode: LOQB302-05, Moth 302.01LZ, all in ANIC; 1 ♀, Lake Barrine, April 1939, E.J. Dumigan, G 158, in UQIC.



Figs 15-16. *Arctornis ravenshoeae* sp. n: (15) Holotype male, Ravenshoe, Qld; (16) Paratype female, Mission Beach, Qld.

Description (Figs 15-16). Head white, frons speckled with light orange, vertex light orange bar between antennae; labial palp white, external surface lightly speckled with orange, more densely orange towards tip; antennal scape light to deep orange, filament white, pectinations long in male, shorter in female, pale brownish yellow. Thorax, white, lightly scaled; legs white, fifth tarsal segment orange, first two legs purplish brown spot on proximal part of tibia and similar spot on first tarsal segment, leg 3 may have small often insignificant pale purplish spot on first tarsal segment. Abdomen lightly scaled, white. Forewing length: male 15-17 mm; female 18-19 mm. Forewing and hindwing glistening white, forewing with slight coruscations caused by fine, irregular longitudinal scale ridges, hindwing less glistening particularly within discal region; in some males forewing with a minute and inconspicuous black discal spot on r-m, discal spot minute but distinct in female; fringes silvery white but in some specimens a hint of grey along termen. Underside of both wings milky white.

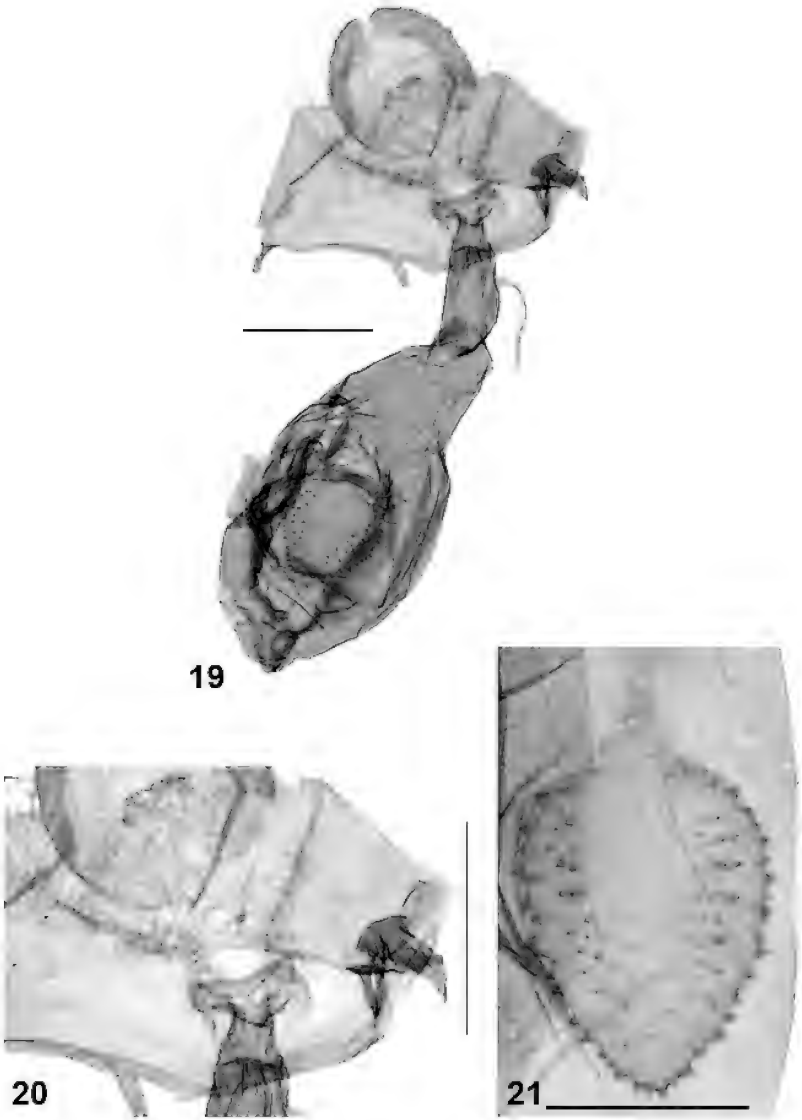
Male genitalia (Figs 17-18). Tegumen and vinculum loosely united; tegumen hood-like, a narrow strap laterally; vinculum narrow U-shaped band widening only slightly in mid line, saccus not developed; uncus short, broad, slightly hooked, shoulders broad, dorsally towards the base with small patch of long fine setae either side of mid-line, a ventral, membranous transverse ridge extending as a lobe on each side of uncus and bearing long fine setae may represent socii; valva lightly sclerotised, subrectangular, widening slightly distally, broadly and shallowly bilobed at apex, lobes bearing long fine setae, sacculi well developed, harpe extending almost complete length of valve, ribbon-like with longitudinal rows of small, robust spines, lightly curved and tapering to a sharp point; juxta lightly sclerotised, r-shaped in lateral view, a subrectangular plate in ventral view with two large lateral depressions either side of a median ridge, both long edges emarginate; aedeagus short, broad and deep, lightly sclerotised except for two well sclerotised, stout, dorso-lateral finger-like lobes arising from carina penis, coecum relatively long, reflexed ventrally, vesica without ornamentation.



Figs 17-18. *Arctornis ravenshoeae* male genitalia: (17) ventral view, Cooper's Creek, Qld, slide G541; (18) aedeagus, Ravenshoe, Qld, slide ANIC19835. Scale bars *ca* 1 mm.

Female genitalia (Figs 19-21). Papillae anales short, broad, in terminal view rounded and rather narrow, densely setose, apophyses posteriores moderate, slightly tapering and extending about half way into segment VIII; segment VIII a broad collar with zone of long setae around posterior margin, mid-ventrally a short broad, partly sclerotised channel extends about half way across sternite and marks opening of sinus vaginalis, lamella antevaginalis forming slight lip at anterior end of channel, lamella postvaginalis present at posterior end of channel forming outwardly projecting shelf that in some views appears as crescentic plate, apophyses anteriores short, flat, barely projecting into segment VII; pseudopapillae well developed, elongate, widening slightly anteriorly; ventrally intersegmental membrane between VIII and ovipositor lobes has an almost membranous sclerite which forms narrow crescentic band; ductus bursae short, membranous; corpus bursae pyriform; signum large, inverted leaf-shaped, covered with short, stout spines except for longitudinally elongate central area.

Diagnosis. Of the Australian *Arctornis* species, *A. ravenshoeae* is only likely to be confused with *A. lucens* and males of *A. commoni* but the genitalia are distinct. Males of *A. ravenshoeae* may be distinguished by the long, straight harpe; females by the presence of the shelf-like lamella postvaginalis and a signum with gracile spines absent in elongate central area.



Figs 19-21. *Arctornis ravenshoeae* female genitalia: (19) overview and (20) sterigma, Kuranda, Qld, slide ANIC19832; (21) signum, Mission Beach, Qld, slide ANIC19841. Scale bars *ca* 1 mm (19-20) or 0.5 mm (21).

Etymology. ravenshoeae (Latin adjective) – pertaining to Ravenshoe, in recognition of the type locality of the species.

Distribution. North Queensland: east coast ranges and adjacent areas from Lizard Island south to Mission Beach.

Remarks. The purplish brown spots on the legs may be obvious or very pale and insignificant; they may be narrowly fringed with orange and the spot on the first tarsal segment of leg 2 may be almost black. The sexes were associated by barcoding.

Arctornis cairnsae sp.n.

(Figs 22-24)

Types. Holotype ♂, QUEENSLAND: Whitfield Range near Cairns, 3.iv.1975, M.S. & B.J. Moulds, ANIC Genitalia No. 19837, in ANIC. *Paratype* ♂, Kuranda, 1-15.xii.2004, D.C.F. Rentz, 335 m, ANIC Genitalia Slde no. 19844, in ANIC.

Additional material examined. QUEENSLAND: 1 ♂, Lake Barrine, 7.i.1939, E.J. Dumigan in UQIC; 2 ♂♂, Lake Barrine, April 1948, K469603 & K469605, in AM.

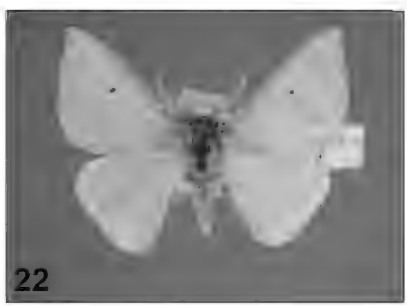
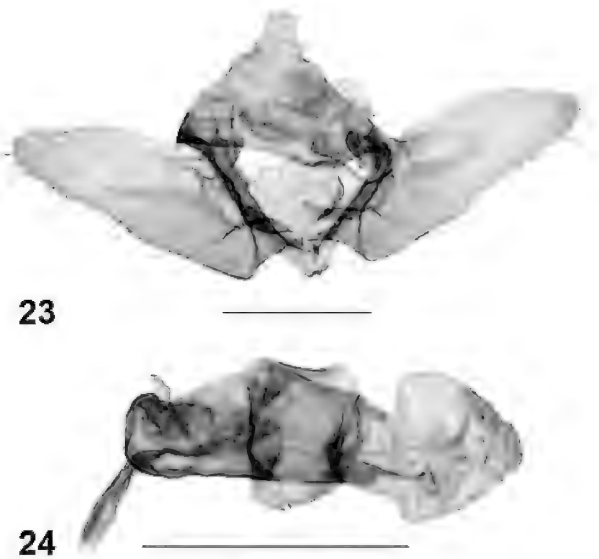


Fig. 22. *Arctornis cairnsae* sp. n. Holotype male, Whitfield Range, Cairns, Qld.

Description (Fig. 22). Male, head white, frons pale buff, vertex brownish orange; labial palp white ventrally, external lateral surface brownish orange; antennal scape brownish orange, filament pale golden yellow, pectinations long, brownish yellow. Thorax pale cream, white ventrally, sparsely scaled; legs, femur white, tarsus and tibia pale cream. Abdomen sparsely scaled, pale cream, slightly glistening. Forewing length: male 15.5-16 mm. Wings lightly scaled, ground colour of fore- and hindwings pale ivory with slight brown irroration particularly along veins and termen, which at some angles appear glistening pale gold; fringes of termen brown. Forewing with small but distinct black, discal spot on r-m. Hindwing paler towards anal margin, which has long white fringes. Underside pale ivory.

Male genitalia (Figs 23-24). Tegumen and vinculum loosely united; tegumen hood-like, very thin and strap-like laterally; vinculum narrow V-shaped band

with slight downward bow in ventral midline, saccus not developed; uncus short and broad with wide shoulders, slightly narrowing towards blunt, slightly hooked end, shoulders bear a small group of long fine setae dorsally either side of mid line; socii may be represented by ventral, membranous transverse ridge extending as lobe each side of uncus and which bears long fine setae; valva subrectangular, long, sharply elbowed dorsally close to base, gently tapering distally to bluntly rounded valvula, sacculus well developed and sharply angled at basal corner, another rather slight angle at about one third to one half of ventral margin of the valve, harpe well developed, ribbon-like, about half length of valve, strongly curved at one third and gradually tapering to fine point; juxta r-shaped in lateral view, a subrectangular plate in ventral view with ventral margin and antero-ventral angles gently rounded, lip of dorsal margin supporting aedeagus slightly bilobed; aedeagus short, broad and deep, lightly sclerotised except for two short, well sclerotised, dorso-lateral finger-like lobes arising from carina penis, coecum relatively long, reflexed ventrally and slightly inflated at its anterior end, vesica without ornamentation.



Figs 23-24. *Arctornis cairnsae* male genitalia, Whitfield Range, Cairns, Qld, slide ANIC19837: (23) ventral view; (24) aedeagus. Scale bars *ca* 1 mm.

Diagnosis. The colouration of the forewings of *A. cairnsae* is distinctive among Australian *Arctornis*.

Etymology. cairnsae (Latin adjective) – pertaining to Cairns in recognition of the type locality of the species.

Distribution. Only recorded from the Cairns region of northern Queensland.

Remarks. Only the male is known.

Arctornis commoni sp.n.

(Figs. 25-27)

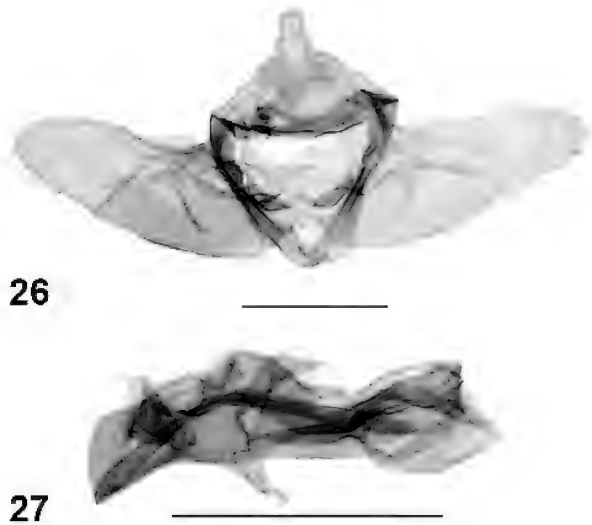
Types. Holotype ♂, QUEENSLAND: Iron Range, 7.iv.1964, I.F.B. Common & M.S. Upton, ANIC Genitalia Slide no. 19840, in ANIC. *Paratypes*: 2 ♂♂, Gordon Creek area, Claudie Riv. district, 22-23.vi.1982, M.A. Schneider, UQIC Reg.# 812816 and 81202, in UQIC.

Fig. 25. *Arctornis commoni* sp. n. Holotype male, Iron Range, Qld.

Description (Fig. 25). Head white, frons heavily irrorated with orange, vertex orange; labial palp white, external surface irrorated with orange, more heavily towards the tip; antennal scape orange, filament white, pectinations long, pale brownish yellow. Thorax white, lightly scaled; legs white, first and second legs with small, pale orange spot on proximal part of tibia, first and fifth tarsal segments light orange, third leg only the fifth tarsal segment marked with pale orange. Abdomen sparsely scaled, white. Forewing length: male 15-16 mm. Wings lightly scaled, glistening white, forewing coruscations caused by irregular longitudinal ridges of scales and with a minute black discal spot on r-m, hindwing matt white across basal half; fringes grey along termen. Underside matt white.

Male genitalia (Figs 26-27). Tegumen and vinculum united; tegumen hood-like, narrowing laterally to join vinculum; vinculum narrow, V-shaped band, saccus not developed; uncus short and broad, shoulders wide, hardly narrowing toward blunt, slightly hooked end, shoulders bearing small group of long, fine setae dorsally either side of mid line; socii may be represented by ventral, membranous transverse ridge extending as lobe each side of uncus and which bears long, fine setae; valva subrectangular, long, sharply

convex dorsally close to base, gently tapering distally to bluntly rounded valvula, sacculus well developed and rounded at basal corner, harpe well developed, narrow, ribbon-like, extending about half length of valve, sharply tapering to blunt point; juxta r-shaped in lateral view, subrectangular plate in ventral view, the ventral margin medially notched, the antero-ventral angles gently rounded, lip of dorsal margin supporting the aedeagus slightly bilobed; aedeagus short, broad and deep, lightly sclerotised except for two well sclerotised, dorso-lateral finger-like lobes arising from carina penis, coecum relatively long, reflexed ventrally, vesica without ornamentation.



Figs 26-27. *Arctornis commoni* male genitalia, Iron Range, Qld, slide ANIC19840: (26) ventral view; (27) aedeagus. Scale bars *ca* 1 mm.

Diagnosis. Arctornis commoni has a similar fascies to *A. lucens* and *A. ravenshoeae* but the short, straight parallel-sided harpe easily distinguishes it from the latter two species. It is possible that worn or slightly discoloured specimens of *A. commoni* may be confused with *A. cairnsae* and these species have similar male genitalia. They may be distinguished by the valve in *A. cairnsae* which is narrower and more or less parallel-sided in its basal half, the sacculus of *A. cairnsae* is angled along the valve margin, the harpe of *A. cairnsae* is shorter after the elbow, the aedeagus of *A. cairnsae* is broader, the finger-like processes on the carina penis therefore appear more widely separated at their base, and they are more gracile than in *A. commoni*, the coecum in *A. cairnsae* is slightly inflated but is not in *A. commoni*.

Etymology. commoni (Latin noun in genitive case) – in honour of Dr Ian Common, who helped lay the foundations for the study of Australian moths and who first collected this species.

Distribution. Only recorded from Iron Range in Cape York Peninsula, northern Queensland.

Remarks. Only the male is known. The thorax and wing bases are often discoloured.

Discussion

The Australian *Arctornis* species have fascies typical of the genus: broad, triangular wings that are generally glistening or satiny white or, occasionally, pale brownish or yellowish. It is possible that Australian species also occur in New Guinea, which is known to have a diverse *Arctornis* fauna although only three species are described. The Australian species were compared with the described New Guinea species but proved quite distinct. The biology of the Australian species is completely unknown but is likely to be similar to that of other species in the genus. The little that is known for the genus was summarised by Holloway (1999). Most of the known host plant families occur in Australia, as do some known host plant genera such as *Mangifera, Terminalia*, *Cinnamomum, Litsea* and *Camellia*. Although *Mangifera* and *Camellia* are not native to Australia, they may be potential hosts for Australian *Arctornis* given the polyphagous habit of many lymantriine species.

Acknowledgements

Sincere thanks to the staff of ANIC, AM, UQIC and QM for access to specimens in their care and to You Ning Su for making available the photomicroscope and for instructions on its use. Dave Britton, Graeme Cocks, Greg Daniels, You Ning Su and Susan Wright have been particularly helpful in providing access to materials in their care. I thank Graeme Cocks, David Mitchell and You Ning Su for providing access to barcode results. I am grateful to Marianne Horak for her critical reading of the manuscript.

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A REVIEW OF THE SUBGENUS *BULLADACUS* DREW & HANCOCK OF *BACTROCERA* MACQUART (DIPTERA: TEPHRITIDAE: DACINAE), WITH DESCRIPTION OF TWO NEW SPECIES FROM PAPUA NEW GUINEA

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Abstract

The *Bactrocera* Macquart subgenus *Bulladacus* Drew & Hancock is reviewed. *Bactrocera (Bulladacus) trilobata* sp. n. and *Bactrocera (Bulladacus) wanangiae* sp. n. are described from Papua New Guinea. *Bactrocera obtrullata* White & Evenhuis, 1999, is placed as a new synonym of *B. diaphana* (Hering, 1953); both were described from Papua Province in eastern Indonesia. The Solomon Islands species *B. unipunctata* (Malloch) is transferred from subgenus *Bactrocera* to *Bulladacus*. Males of *B. aceromata* White & Evenhuis are newly described. Records of *B. mcgregori* (Bezzi) from Singapore, West Malaysia and the Andaman and Nicobar Islands are regarded as misidentifications of *B. cinnabaria* Drew & Romig. *Bactrocera pacificae* Drew & Romig is newly recorded from Papua New Guinea. A key to the 20 known species is included.

Introduction

The *Bactrocera* Macquart subgenus *Bulladacus* Drew & Hancock is defined as having the posterior lobe of the male surstylus short, abdominal sternite V of male deeply concave on posterior margin [this combination of characters placing it in the *Bactrocera* group of subgenera], plus a combination of all or most of the following characters: antenna shorter than usual for the genus, pecten of cilia present on male abdominal tergite III, distinct oval shining spots (ceromata) on abdominal tergite V absent, one pair of scutellar setae, prescutellar acrostichal seta present, supra-alar seta present or absent, wing cell bcu with extension short, wing of male with bulla present near apex of cell bcu extension (Drew and Hancock 1995, White and Evenhuis 1999, Drew and Romig 2013). In addition, both the anatergite and katatergite are largely yellow, the notopleural lobe is often partly or entirely red-brown, fuscous or black, facial spots are often absent and most species have a broad anepisternal yellow stripe that reaches the postpronotal lobe and an isolated medial black vitta on tergite V that often crosses onto tergite IV but seldom extends onto tergite III. The male bulla and pecten of cilia on abdominal tergite III are absent in *B. aceraglans* White & Evenhuis but a patch of cilia occurs on the wing where the bulla is normally situated. In males where a distinct bulla is present, the cell bcu extension is often longer and narrower than usual. No species in the subgenus shows a response to known male lures.

Bulladacus appears to be most closely related to subgenus *Calodacus* Hancock that, like it, has comparatively short antennae, a short cell bcu extension and shows no response to known male lures (Hancock 2015); the latter subgenus differs primarily in the presence of ceromata on abdominal tergite V. Known hosts of *Bulladacus* species are primarily the fruit of

Gnetum gnemon (Gnetaceae) and *Terminalia* species (Combretaceae), with only occasional records from other plant families.

The following abbreviations have been used: QDAF – Queensland Department of Agriculture and Fisheries collection, Brisbane; QM – Queensland Museum, Brisbane. Descriptive terminology follows White *et al.* (1999), with bilateral structures (vittae, setae, etc.) listed in the singular.

Bactrocera (Bulladacus) Drew & Hancock

Bactrocera (Bulladacus) Drew & Hancock, 1995: 9. Type species: *Bactrocera gnetum* Drew & Hancock, by original designation.

Twenty species are known, the subgenus ranging from the Philippines and southern Thailand/Andaman Islands to the South Pacific as far east as Fiji and Samoa. Two species occur in Australia, five in the Pacific Islands and at least nine in Papua New Guinea.

Bactrocera (Bulladacus) aceraglans White & Evenhuis

Bactrocera (Bulladacus) aceraglans White & Evenhuis, 1999: 506 (♂). Type locality: Minj, Western Highlands, Papua New Guinea.

Description. See White and Evenhuis (1999). This species differs from all others in the presence of a patch of cilia, rather than a bulla, alongside wing cell bcu in males. The notopleural lobe is dark fuscous to black.

Distribution. Papua New Guinea (Western Highlands Province).

Host plant. Unknown.

Bactrocera (Bulladacus) aceromata White & Evenhuis (Fig. 1)

Bactrocera (Bulladacus) aceromata White & Evenhuis, 1999: 509 (♀). Type locality: Tapini, Papua New Guinea.

Material examined. PAPUA NEW GUINEA: Madang Province – 29 ♂♂, 28 ♀♀, Baitabag and Ohu, March, April and September 2001, reared from *Gnetum gnemon* and *Gnetum costatum*; Morobe Province – 24 ♂♂, 28 ♀♀, Lae, February, March and April 2000, reared from *Gnetum gnemon* and *Sandoricum koetjape*. Specimens in QDAF.

Description. Male. Head: height 1.2 mm; frons length 1.3 times breadth, red-brown without dark markings; setae black: 2 frontal, 1 orbital; lunule red-brown; ocellar triangle black; vertex red-brown; face entirely fulvous without dark markings, length 0.5 mm; gena fulvous without dark markings, black seta present; occiput red-brown, fulvous along eye margins; occipital row with 3-6 strong black setae. Antenna with all segments red-brown; length of segments 0.12 mm, 0.24 mm, 0.45 mm; first flagellomere (segment 3) strongly truncate (square) across apex (not rounded as in most *Bactrocera* species).

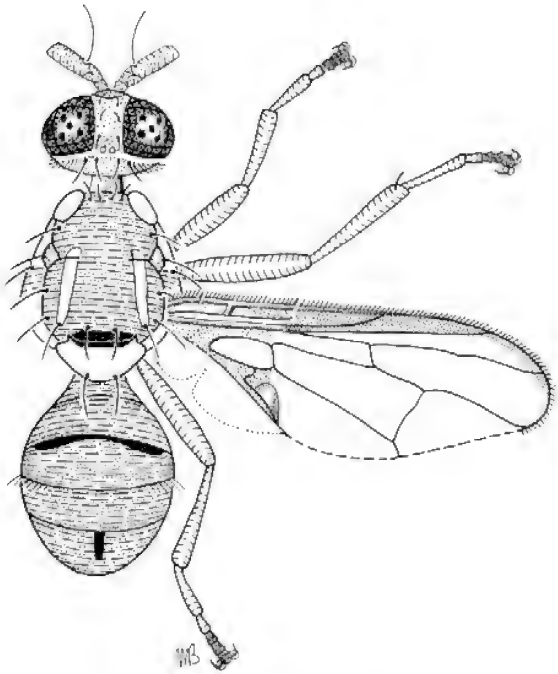

Fig. 1. *Bactrocera (Bulladacus) aceromata* White & Evenhuis, male.

Thorax. Scutum entirely red-brown with a broad transverse black band across posterior margin. Yellow markings as follows: postpronotal lobe; anepisternal stripe reaching postpronotal lobe dorsally, continuing to katepisternum as a transverse spot, anterior margin straight; anatergite (posterior apex black); anterior 2/3 of katatergite (remainder black); broad parallel-sided lateral postsutural vitta beginning with a large spot anterior to notopleural suture and ending at intra-alar seta; medial postsutural yellow vitta absent. Postnotum red-brown centrally, black laterally. Notopleural lobe red-brown. Scutellum yellow except for a narrow black basal band. Setae: 2 scapular; 2 notopleural; 1 anepisternal; 1 supra-alar; 1 postalar; 1 intra-alar; 1 prescutellar acrostichal; 1 (apical) scutellar.

Legs. All leg segments entirely fulvous except apical three segments of all tarsi dark fuscous; mid tibia with an apical black spur.

Wing. Length 4.2 mm; cells bc and c pale fuscous; dense microtrichia covering cell c only; remainder of wing colourless except fuscous cell sc, narrow fuscous costal band confluent with R_{2+3} and remaining narrow around apex of wing, a distinct large bulla across extension of cell bcu and pale

fuscous in area normally covered by anal streak; aggregation of microtrichia around A_1+Cu_2 less dense than in most species of *Bactrocera*; supernumerary lobe weak.

Abdomen. Oval; tergites free; strong black pecten present on tergite III. All tergites red-brown except for a narrow transverse black band across anterior margin of tergite III and a moderately broad medial black vitta over anterior l/2 of tergite V. No shining spots (ceromata) on tergite V. All abdominal sternites red-brown; sternite V with a deep concavity on posterior margin. Surstylus with posterior lobe short.

Female. As for male except no bulla on wing; pecten of cilia absent from abdominal segment III; oviscape red-brown, dorsoventrally compressed and tapering slightly in dorsal view; ratio of length of oviscape to length of tergite V, 0.3:1; apex of aculeus needle shaped.

Distribution. Papua New Guinea (Madang, Morobe and Central Provinces north of the Owen Stanley Range).

Host plants. Gnetum gnemon and *Gnetum costatum. Bactrocera (Bulladacus)* species utilise *Gnetum* species as primary hosts across their geographic range, except in Australia where *Gnetum* is absent; the record from *Sandoricum koetjape* (Meliaceae) listed under material examined is possibly an error.

Comments. *Bactrocera aceromata* is similar to *B. (Bulladacus) cinnabaria* Drew & Romig in possessing a red-brown scutum, mostly red-brown abdominal tergites, wings without infuscation except for the costal band and anal streak and femora entirely pale (fulvous to red-brown). It differs from *B. cinnabaria* in having the costal band very narrow around the wing apex and in lacking black lateral margins on abdominal tergites IV and V.

Bactrocera (Bulladacus) aenigmatica (Malloch)

Dacus aenigmaticus Malloch, 1931: 261 (♀). Type locality: Malololelei, Upolu, Western Samoa.

Bactrocera (Bulladacus) aenigmatica (Malloch): Drew and Hancock 1995: 9 (♂♀).

Description. See Drew (1989) and Drew and Hancock (1995).

Distribution. Western Samoa (Upolu and Savaii).

Host plant. Aglaia samoensis (Meliaceae) (Drew and Hancock 1995).

Comments. The lengths of the antennal segments, previously unrecorded, are 0.1 mm, 0.2 mm and 0.46 mm and the first flagellomere is apically rounded.

Bactrocera (Bulladacus) bullata Drew

Bactrocera (Bactrocera) bullata Drew, 1989: 124 (♂♀). Type locality: Abelam, East Sepik district, Papua New Guinea.

Bactrocera (Bulladacus) bullata: Drew and Hancock 1995: 9.

Material examined. PAPUA NEW GUINEA: Madang Province – a large series of specimens collected at Ohu, October 2000 and February to October 2001, recorded as reared from *Phaleria macrocarpa*; a large series of specimens collected at Baitabag, May to October 2001, recorded as reared from *Phaleria macrocarpa*; Morobe Province – a large series of specimens, May 2000, reared from an unknown host at the Lae Forest Research Institute. Specimens in QDAF.

Description. See Drew (1989).

Distribution. Papua New Guinea (East Sepik, Madang and Morobe Provinces).

Host plants. Phaleria macrocarpa (Thymeliaceae) (Novotny *et al.* 2005 and above records) and *Gnetum gnemon* (Gnetaceae) (Leblanc *et al.* 2012). A record from *Garcinia* sp. (Clusiaceae) (Drew 1989) is probably an error.

Bactrocera (Bulladacus) bullifera (Hardy)

Dacus (Strumeta) bulliferus Hardy, 1973: 32 (♂). Type locality: Songkhla, Thailand.

Bactrocera (Bulladacus) bullifera: Drew and Hancock 1995: 9; Drew and Romig 2013 (♂♀).

Description. See Drew and Romig (2013).

Distribution. Southern Thailand, Peninsular Malaysia, East Malaysia (Sarawak), Indonesia (Java, Sumatra).

Host plant. Gnetum gnemon (Gnetaceae) (Drew and Romig 2013).

Bactrocera (Bulladacus) captiva Drew & Romig

Bactrocera (Bulladacus) captiva Drew & Romig, 2013: 196 (♂♀). Type locality: 'Philippines'.

Description. See Drew and Romig (2013).

Distribution. Philippines (precise locality unknown).

Host plant. Eugenia javanica (Myrtaceae) – possibly incorrect, the type series and host record stemming from quarantine interception at Narita Airport, Japan (Drew and Romig 2013).

Bactrocera (Bulladacus) cinnabaria Drew & Romig

Dacus (Strumeta) mcgregori: Hardy and Adachi 1954: 176 (♂♀). Singapore. Misidentification.

Bactrocera (Bulladacus) cinnabaria Drew & Romig, 2013: 197 (♂♀). Type locality: Arong, Car Nicobar, India.

Description. See Drew and Romig (2013).

Distribution. India (Andaman and Nicobar Is), West Malaysia and Singapore.

Host plants. Gnetum gnemon (Gnetaceae) (Hardy and Adachi 1954, Yong 1994) and *Gnetum* sp. (Drew and Romig 2013).

Comments. The abdominal pattern is a little variable, with the black medial vitta on tergites IV-V often interrupted or absent on tergite IV. Records of *B. mcgregori* from Singapore (Hardy 1973, 1974), West Malaysia (Yong 1994) and the Andaman and Nicobar Islands (David and Ramani 2011) are regarded as misidentifications of *B. cinnabaria*, with *B. mcgregori* differing in the presence of a presutural yellow vitta and longer, more parallel-sided lateral postsutural yellow vitta that extends anterior to the suture as a distinct spot.

Bactrocera (Bulladacus) diaphana (Hering)
(Fig. 2)

Strumeta diaphana Hering, 1953: 508 (♀). Type locality: Bernhard Camp, Papua Province, Indonesia.

Bactrocera (Bactrocera) diaphana: Drew 1989: 130.

Bactrocera (Bulladacus) obtrullata White & Evenhuis, 1999: 510 (♂). Type locality: Dojo, Papua Province, Indonesia. **Syn. n.**

Material examined. PAPUA NEW GUINEA: Madang Province – 1 ♂, 2 ♀♀, Baitabag, 17.i.2001, reared from *Pimelodendron amboinicum*; Morobe Province – 2 ♂♂, 4 ♀♀, Lae Forest Research Institute Botanical Gardens, 29.iii.2000, reared from *Sandoricum koetjape*. Specimens in QDAF.

Description. Male. Head: Height 1.2 mm; frons length 1.4 times breadth, red-brown with pale fuscous to fuscous centrally; setae black: 2 frontal, 1 orbital; lunule fuscous; ocellar triangle black; vertex red-brown; face entirely fulvous without dark markings, length 0.5 mm; gena fulvous without dark markings, black seta present; occiput pale fuscous, fulvous along eye margins; occipital row with 2-3 weak black setae. Antenna with all segments red-brown; length of segments: 0.1 mm, 0.2 mm, 0.4 mm; first flagellomere rounded at apex.

Thorax. Scutum red-brown with two submedial black bands that are broad posteriorly and narrowing anteriorly and joined across posterior area of scutum with fuscous colouration, black on lateral margins between postpronotal lobe and notopleuron and inside notopleuron. Yellow markings as follows: postpronotal lobe; anepisternal stripe reaching to anterior notopleural seta dorsally, continuing to katepisternum as a large spot, anterior margin straight; anatergite (posterior apex black); anterior 2/3 of katatergite (remainder black); broad parallel-sided lateral postsutural vitta beginning as a large spot anterior to notopleural suture and ending at intra-alar seta; a lateral yellow band between posterior margin of postpronotal lobe and yellow spot anterior to notopleural suture; medial postsutural yellow vitta absent. Postnotum red-brown centrally, black laterally. Notopleural lobe red-brown. Scutellum yellow with a narrow black basal band that widens laterally. Setae: 2 scapular; 2 notopleural; 1 anepisternal; 1 supra-alar; 1 postalar; 1 intra-alar; 1 prescutellar acrostichal; 1 (apical) scutellar.

Legs. All leg segments entirely fulvous except hind tibiae dark fuscous basally to fuscous apically; mid tibia with an apical black spur.

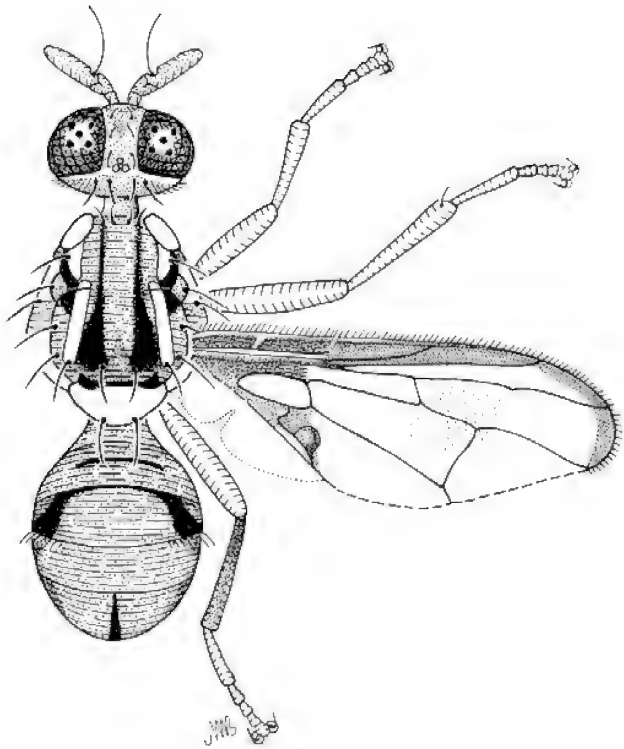

Fig. 2. *Bactrocera (Bulladacus) diaphana* (Hering), male.

Wing. Length 4.4 mm; cells bc and c dark fuscous and covered with dense microtrichia; remainder of wing colourless except dark fuscous cell sc, narrow fuscous costal band confluent with R_{2+3} and continuing around costal margin to apex of vein M, a pale tint in centre of wing, distinct large dark bulla across extension of cell bcu and fuscous in area normally covered by anal streak; a dense aggregation of microtrichia around A_1+Cu_2; supernumerary lobe weak.

Abdomen. Oval; tergites free; a strong black pecten present on tergite III. All tergites red-brown except for a narrow black band submedially on tergite I+II, a narrow black band across anterior margin of tergite III which expands over lateral margins, a medium width medial black vitta over tergite V and fuscous to dark fuscous anterolateral corners of tergites IV and V. No shining spots (ceromata) on tergite V. All abdominal sternites red-brown; sternite V with a deep concavity on posterior margin. Surstylus with posterior lob short.

Female. As for male except face with a pair of medium-sized oval black spots, notopleuron with anterior 1/2 fuscous and posterior 1/2 yellow, wing with cells bc and c colourless and lacking a bulla over extension of cell bcu; apex of aculeus needle shaped, ratio of length of oviscape to length of tergite V, 1:1.

Distribution. Indonesia (Papua Province); Papua New Guinea (Madang and Morobe Provinces).

Host plants. Recorded hosts are *Pimelodendron amboinicum* (Euphorbiaceae) (Novotny *et al.* 2005 and above records) and *Sandoricum koetjape* (Meliaceae). If these are correct plant identifications then they are a significant departure from those of most other *B. (Bulladacus)* species.

Comments. The female holotype of *B. diaphana* was examined, described and illustrated by Drew (1989). The rearing of both sexes from the same host fruit has now made possible the correct subgeneric placement for this species and the description of the male.

Bactrocera (Bulladacus) diaphana exhibits a low level of sexual dimorphism. It is similar to *B. (Bulladacus) mcgregori* (Bezzi) in general body and wing colour patterns and in possessing a lateral yellow vitta between the postpronotal lobe and notopleural suture. It differs from *B. mcgregori* in having apex of antennal first flagellomere rounded apically, a narrower anepisternal stripe and face fulvous with a pair of black spots in females. The original description of *B. diaphana* was based on a female specimen and that of *Bactrocera (Bulladacus) obtrullata* White & Evenhuis on male specimens. Now that we have studied both sexes reared from the same host plant sample, we can confirm that *B. obtrullata* is a new synonym of *B. diaphana*, being identical in all significant morphological characters.

Bactrocera (Bulladacus) eximia Drew

Bactrocera (Bactrocera) eximia Drew, 1989: 132 (♂♀). Type locality: Baku, Madang Province, Papua New Guinea.

Bactrocera (Bulladacus) eximia: Drew and Hancock 1995: 9.

Description. See Drew (1989).

Distribution. Papua New Guinea (Madang and Central Provinces).

Host plants. Terminalia brassii and *T. catappa* (Combretaceae) (Drew 1989, Leblanc *et al.* 2012).

Bactrocera (Bulladacus) flavinotus (May)

Afrodacus flavinotus May, 1957: 293 (♀). Type locality: Atherton, Queensland.

Bactrocera (Bulladacus) neotigrina Drew & Hancock, 1999: 7 (♂♀), in Drew *et al.* 1999. Type locality: Helenvale nr Cooktown, Queensland. Syn. Drew and Hancock 2000: 27.

Bactrocera (Bulladacus) flavinotus: Drew and Hancock 2000: 27.

Description. See May (1957) and Drew *et al.* (1999).

Distribution. Northern Queensland (Cooktown to Atherton and Gordonvale).

Host plant. Terminalia sericocarpa (Combretaceae) (Drew *et al.* 1999).

Bactrocera (Bulladacus) gnetum Drew & Hancock

Bactrocera (Bulladacus) gnetum Drew & Hancock, 1995: 9 (♂♀). Type locality: Saivou, Vanua Levu, Fiji.

Description. See Drew and Hancock (1995).

Distribution. Fiji.

Host plant. Gnetum gnemon (Gnetaceae) (Drew and Hancock 1995).

Bactrocera (Bulladacus) mcgregori (Bezzi)

Chaetodacus mcgregori Bezzi, 1919: 426 (♂♀). Type locality: Batbatan Island, Philippines.

Bactrocera (Bulladacus) mcgregori: Drew and Hancock 1995: 9.

Description. See Drew and Romig (2013).

Distribution. Philippines (Panay and Batbatan Is), Records from Singapore (Hardy and Adachi 1954, Hardy 1973, 1974), West Malaysia (Yong 1994) and the Andaman and Nicobar Islands (David and Ramani 2011) are transferred to *B. cinnabaria.*

Host plant. Unknown. Previous records of *Gnetum gnemon* (Hardy and Adachi 1954, Hardy 1973, 1974, Yong 1994) refer to *B. cinnabaria.*

Bactrocera (Bulladacus) pacificae Drew & Romig

Bactrocera (Bulladacus) pacificae Drew & Romig, 2001: 138 (♂♀). Type locality: Vatina, Guadalcanal, Solomon Islands.

Material examined. PAPUA NEW GUINEA: Central Province – 14 ♂♂, 14 ♀♀, Hiritano Highway, Doa Forest, 22.x.1999, reared from *Gnetum gnemon*; 1 ♀, Rouna Forest, 2.ii.1999, reared from *Gnetum gnemon*, coll. Drew *et al.*; Madang Province – 1 ♂, 2 ♀♀ (10.i.2001), 1 ♂ (1.ii.2001), Ohu, reared from *Gnetum gnemon*; 1 ♀, Baitabag, 25.x.2000, reared from *Gnetum gnemon*. Specimens in QDAF.

Description. See Drew and Romig (2001).

Distribution. Solomon Islands (Guadalcanal and Temotu Province (Lom Lom and Nendo Islands)) and Papua New Guinea (Central and Madang Provinces).

Host plant. Gnetum gnemon (Gnetaceae) (Drew and Romig 2001, Leblanc *et al.* 2012).

Comments. Bactrocera pacificae is distinct in possessing a red-brown scutellum with lateral yellow margins. The above new records from Papua New Guinea indicate a wider distribution than previously considered.

Bactrocera (Bulladacus) penefurva Drew

Bactrocera (Bactrocera) penefurva Drew, 1989: 151 (♂). Type locality: 20 km SE Port Moresby, Papua New Guinea.

Bactrocera (Bulladacus) penefurva: Drew and Hancock 1995: 9; Drew and Romig 2001 (♂♀).

Material examined. PAPUA NEW GUINEA: Madang Province – a large series of specimens collected at Baitabag, January to March 2001, reared from *Terminalia* sp.; Morobe Province – a large series of specimens collected at Bundun Conference Centre Lae, Lae Forest Research Institute Botanical Gardens and Oomsis Forest, February to May 2000, reared from *Terminalia* sp. Specimens in QDAF.

Description. This species has been described and illustrated by Drew (1989) and Drew and Romig (2001). One additional character is that, in both sexes, the apex of the antennal first flagellomere is rounded, not truncate as in some *B. (Bulladacus)* species.

Distribution. Papua New Guinea (Central, Morobe and Madang Provinces) and Solomon Islands (Guadalcanal).

Host plants. Terminalia catappa and *T. kaernbachii* (Combretaceae) (Drew and Romig 2001). A record from *Gnetum gnemon* (Gnetaceae) (Leblanc *et al.* 2012, Hollingsworth *et al.* 2003: Table 5) appears to be based on a *lapsus* for *B. pacificae*.

Bactrocera (Bulladacus) peterseni (Hardy)

Dacus (Strumeta) peterseni Hardy, 1970: 75 (♂). Type locality: Tarawakan, Tawi Tawi, Philippines.

Bactrocera (Bulladacus) peterseni: Drew and Hancock 1995: 9.

Description. See Drew and Romig (2013).

Distribution. Philippines (Tawi Tawi I.).

Host plant. Unknown.

Bactrocera (Bulladacus) tigrina (May)

Afrodacus tigrinus May, 1952: 335 (♀); 1957: 296 (♂). Type locality: Kamerunga, Cairns, Queensland.

Afrodacus furvus May, 1957: 294 (♂♀). Type locality: Atherton, Queensland. Syn. Drew 1989: 24.

Bactrocera (Bulladacus) tigrina: Drew and Hancock 1995: 9.

Description. See May (1952, 1957), Drew (1989) and Drew *et al.* (1999).

Distribution. Northern Queensland (Iron Range to Murray Falls near Tully).

Host plants. Terminalia sericocarpa and *T. muelleri* (Combretaceae) (Drew *et al.* 1999).

Bactrocera (Bulladacus) trilobata sp. n.

(Fig. 3)

Type material. *Holotype* ♂, PAPUA NEW GUINEA: Madang Province, Mis Village, 5°11'S 145°47'E, 25.viii.2008, coll. Ctvrtecka, Brus & Rimandai, reared from *Phaleria macrocarpa*. *Paratypes*: 1 ♂, 5 ♀♀, same data as holotype. Holotype and 1 paratype in QM (Reg. Nos T234939 (HT) and T234940 (PT)); 5 paratypes in QDAF.

Description. Male. Head: Height 1.1 mm; frons length 1.6 times breadth, red-brown without dark markings; orbital setae black: 2 frontal, 1 orbital; lunule red-brown; ocellar triangle black; vertex red-brown.; face entirely fulvous without dark markings, length 0.4 mm; gena fulvous without dark markings, weak pale seta present; occiput red-brown, fulvous along eye margins, occipital row with 1-3 dark setae. Antenna with all segments red-brown; length of segments: 0.1 mm, 0.15 mm, 0.5 mm; first flagellomere rounded at apex.

Thorax. Scutum red-brown without dark markings. Yellow markings as follows: postpronotal lobe; anepisternal stripe reaching postpronotal lobe dorsally, continuing to katepisternum as a transverse spot, anterior margin straight; anatergite (posterior apex red-brown); anterior l/2 of katatergite (remainder red-brown); narrow lateral postsutural vitta narrowing slightly posteriorly to end just before intra-alar seta; no distinct spot anterior to notopleural suture; medial postsutural yellow vitta absent. Postnotum red-brown centrally, black laterally. Notopleural lobe red-brown. Scutellum yellow with a narrow black basal band. Setae: 2 scapular; 2 notopleural; 1 anepisternal; 1 supra-alar; 1 postalar; 1 intra-alar; 1 prescutellar acrostichal; 1 (apical) scutellar.

Legs. All leg segments entirely fulvous except apical three segments of all tarsi red-brown; mid tibia with an apical black spur.

Wing. Length 4.4 mm; cells bc and c pale fuscous with dense microtrichia in outer corner of cell c only; remainder of wing colourless except fuscous cell sc., narrow fuscous costal band confluent with R_{2+3} and remaining narrow around wing margin to end at apex of vein M, narrow fuscous transverse band enclosing DM-Cu crossvein, broad fuscous anal streak, small fuscous bulla around apex of cell bcu extension. No dense aggregation of microtrichia around A_1+Cu_2. Supernumerary lobe weak.

Abdomen. Oval; tergites free; a strong pecten present on tergite III. All tergites red-brown except for a short, medial, narrow black vitta on posterior margin of tergite V. No shining spots (ceromata) on tergite V.

Female. As for male except bulla on wing and pecten of cilia on abdominal tergite III both absent; oviscape red-brown, dorsoventrally compressed and tapering slightly in dorsal view; ratio of length of oviscape to length of tergite V, 1:1, apex of aculeus trilobed (Fig. 3).

Etymology. Named as an adjective after the trilobed aculeus.

Distribution. Papua New Guinea (Madang Province).

Host plant. *Phaleria macrocarpa* (Thymelaeaceae).

Comments. *Bactrocera (Bulladacus) trilobata* sp. n. is similar to *B. (Bulladacus) aenigmatica* (Malloch), *B. (Bulladacus) cinnabaria* Drew & Romig and *B. (Bulladacus) pacificae* Drew & Romig in possessing a red-brown scutum, a narrow costal band confluent with R_{2+3}, lateral postsutural yellow vitta short and narrow and ending before the intra-alar seta and additionally to *B. cinnabaria* in having a broad anepisternal stripe reaching to the postpronotal lobe. It differs from all three species in having the DM-Cu crossvein enclosed with fuscous colouration and the apex of the aculeus trilobed.

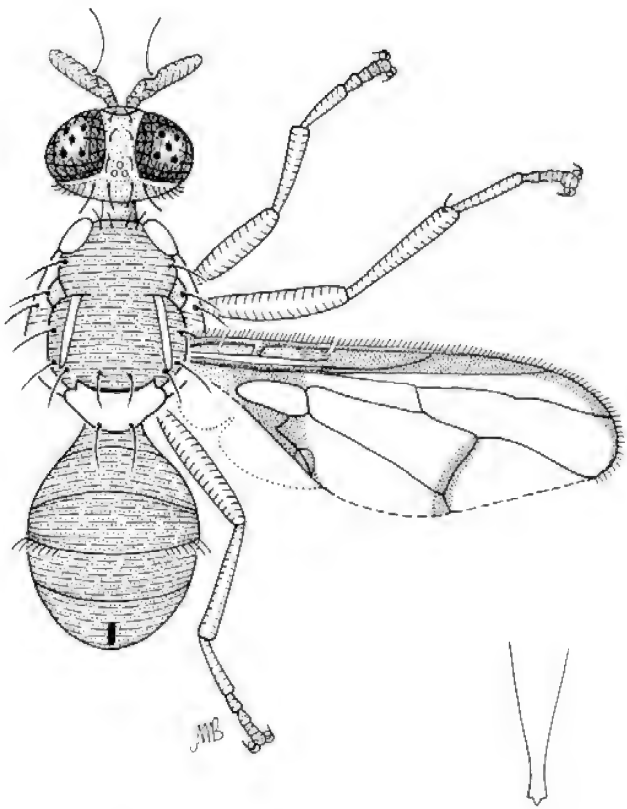

Fig. 3. *Bactrocera (Bulladacus) trilobata* sp. n., male and female aculeus.

Bactrocera (Bulladacus) unipunctata (Malloch)

Dacus unipunctatus Malloch, 1939: 245 (♂). Type locality Tulagi, Florida I., Solomon Islands.

Bactrocera (Bactrocera) unipunctata: Drew 1989: 167.

Description. See Drew (1974, 1989) and Drew and Romig (2001).

Distribution. Solomon Islands (Florida I.).

Host plant. Unknown.

Comments. The short antennal segments (0.08, 0.18, 0.5 mm), short wing cell bcu extension and lack of ceromata on abdominal tergite V place this species in *Bulladacus* and it is therefore transferred from subgenus *Bactrocera*. It also has an oval abdomen with a single black medial spot on tergite V and microtrichia over much of cells bc and c, typical of many *Bulladacus* species. The pecten of cilia and bulla appear to be absent but the only known specimen is damaged and teneral and both structures are possibly present.

***Bactrocera (Bulladacus) wanangiae* sp. n.**

(Fig. 4)

Bactrocera (Bulladacus) sp. near *aceraglans* White & Evenhuis, 1999: 507 (♂). Wanuma, Madang Province, Papua New Guinea.

Type material. Holotype ♂, PAPUA NEW GUINEA: Morobe Province, Wanang, 4.xii.2008, Ctvrtecka *et al.*, reared ex unidentified fruit. *Paratype* ♂, same data as holotype. Types in QM (Reg. Nos T234941 (HT) and T234942 (PT)).

Description. Male. Head: Height 1.2 mm; frons length 1.8 times breadth, red-brown with dark fuscous on anteromedial hump; orbital setae black: 2 frontal, 1 orbital; lunule red-brown; ocellar triangle black; vertex red-brown; face entirely fulvous, length 0.5 mm; gena red-brown; occiput red-brown, fulvous along eye margins, occipital row with 4-5 strong pale setae. Antenna abraded.

Thorax. Scutum black with red-brown bordering postpronotal lobe, around notopleural suture and below and behind lateral postsutural vitta. Yellow markings as follows: postpronotal lobe; anepisternal stripe reaching postpronotal lobe dorsally, continuing to katepisternum as a small spot, anterior margin straight; anatergite (posterior apex black); anterior 2/3 of katatergite (remainder black); broad parallel-sided lateral postsutural vitta beginning as a small spot anterior to notopleural suture and ending just behind intra-alar seta; medial postsutural yellow vitta absent. No lateral yellow area between postpronotal and notopleural lobes. Pleural areas dark fuscous to black. Postnotum red-brown centrally, black laterally. Notopleural lobe yellow. Scutellum yellow with a narrow black basal band. Setae: 2 scapular; 2 notopleural; 1 anepisternal; 1 supra-alar; 1 postalar; 1 intra-alar; 1 prescutellar acrostichal; 1 (apical) scutellar.

Legs. All segments entirely fulvous.

Wing. Length 5.4 mm; cells bc and c pale fuscous with dense microtrichia over all of cell c and outer half of cell bc; remainder of wing colourless except fuscous cell sc., narrow fuscous costal band confluent with R_{2+3} and remaining narrow around wing margin to end between apices of R_{4+5} and M, narrow infuscation enclosing R-M and DM-Cu crossveins that is also connected with infuscation along M, broad pale fuscous anal streak, distinct red-brown bulla around apex of cell bcu extension. No dense aggregation of microtrichia around A_1+CuA_2. Supernumerary lobe of medium development.

Abdomen. Abdomen oval; tergites free; a weak pale pecten present on tergite III. All tergites red-brown except for a narrow medial black vitta over tergite V. No shining spots (ceromata) on tergite V.

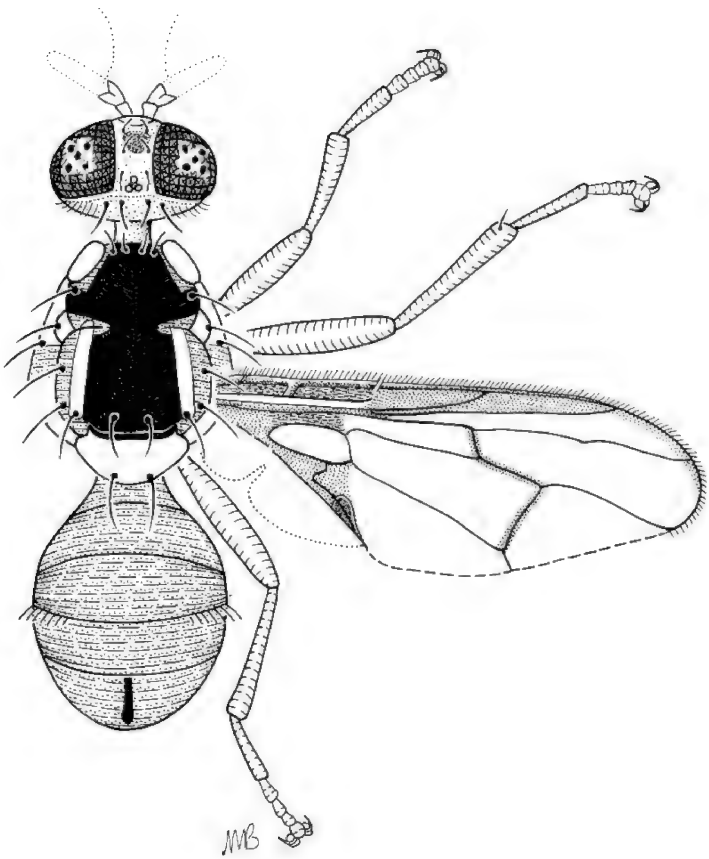

Fig. 4. *Bactrocera (Bulladacus) wanangiae* sp. n., male.

Female. Unknown.

Etymology. Named after the type locality.

Distribution. Papua New Guinea (Madang and Morobe Provinces).

Host plant. Unknown.

Comments. *Bactrocera (Bulladacus) wanangiae* sp. n. is similar to *B. (Bulladacus) gnetum* Drew & Hancock in possessing a black scutum without a medial postsutural yellow vitta, wing with a narrow fuscous costal band and fulvous leg segments. It differs from *B. gnetum* in having a broad parallel-sided lateral postsutural yellow vitta and infuscation enclosing R-M and DM-Cu crossveins that is connected by infuscation along vein M. The '*B.* sp nr *aceraglans*' of White and Evenhuis (1999) is associated based on its original description and illustration.

Bactrocera (Bulladacus) warisensis White & Evenhuis

Bactrocera (Bulladacus) warisensis White & Evenhuis, 1999: 512 (♂). Type locality: Waris, S of Jayapura, Papua Province, Indonesia.

Description. See White and Evenhuis (1999).

Distribution. Indonesia (Papua Province).

Host plant. Unknown.

Key to species of subgenus *Bulladacus*

1 Scutum with a medial postsutural yellow vitta 2

– Scutum without a medial postsutural yellow vitta 7

2 Scutum red-brown or with a pair of submedial black vittae; male with bulla either small and distinct or weak and undeveloped 3

– Scutum mostly black; male with bulla distinct and well developed 4

3 Scutum with a pair of dark submedial vittae; lateral postsutural yellow vitta extending anterior to suture as a distinct spot; medial postsutural yellow vitta narrowly triangular and almost as long as lateral vitta; wing with a dark band over DM-Cu crossvein; male with a small distinct bulla over apex of cell bcu extension (Papua New Guinea) ..... *B. bullata*

– Scutum without a pair of dark submedial vittae; lateral postsutural yellow vitta not extending anterior to suture; medial postsutural yellow vitta broadly triangular and distinctly shorter than lateral vitta; wing without a dark band over DM-Cu crossvein; male with bulla weak and undeveloped (Australia) ..... *B. flavinotus*

4 Sexes similar, the costal band narrow throughout and not expanded into a broad, isolated apical patch in males; abdomen orange-brown with narrow black lateral margins on tergites III-IV and a black medial vitta on tergite V (Papua New Guinea) ..... *B. eximia*

– Sexes dissimilar, the costal band narrow in females, expanded into a broad, isolated apical patch in males; abdomen with black areas as sublateral spots or patches on tergites III-V (males) or with black transverse bands on tergite III (and often I+II) and black lateral margins on tergites III-V (females) 5

5 Medial postsutural vitta reaching line of suture anteriorly; abdomen without a dark transverse band or sublateral patches on tergite I+II; male wing with apical patch crossing vein M and reaching almost to DM-Cu crossvein (Papua New Guinea and Solomon Islands) ..... *B. penefurva*

– Medial postsutural vitta not reaching line of suture anteriorly; abdomen with a dark transverse band or sublateral patches on tergite I+II; male wing with apical patch as above or smaller and not crossing vein M 6

6 Medial postsutural vitta broadly triangular and distinctly shorter than lateral vitta; male wing with apical patch not crossing vein M and approaching it well distad of DM-Cu crossvein (Australia) ..... *B. tigrina*

– Medial postsutural vitta broadly oval and almost as long as lateral vitta; male wing with apical patch crossing vein M and reaching almost to DM-Cu crossvein (Philippines) ..... *B. captiva*

7 Costal band broadly expanded medially with a triangular dark band across both R-M and DM-Cu crossveins; male bulla present over apex of cell bcu extension (Papua Province, eastern Indonesia) ..... *B. warisensis*

– Costal band narrow or expanded apically but not expanded across R-M and DM-Cu crossveins; male bulla variably placed or absent 8

8 Scutum black except for lateral postsutural yellow vitta; costal band very narrow and of uniform width beyond apex of vein R_{2+3} 9

– Scutum largely fulvous to red-brown or with dark submedial and sometimes medial vittae; costal band narrow or broadened apically 11

9 Scutum with lateral postsutural yellow vitta short and sharply tapered posteriorly; abdomen with a broad black lateral vitta on tergites III-V and a broad medial vitta from posterior margin of tergite III to tergite V; male with bulla large and ovate (Fiji) ..... *B. gnetum*

– Scutum with lateral postsutural yellow vitta elongate and parallel-sided, enclosing intra-alar seta; abdomen orange-brown, at most with a black medial vitta on tergite V; male bulla indistinct or absent 10

10 Wing with a dark posterior stripe over DM-Cu crossvein to wing margin; fore and apical halves of mid and hind femora fuscous; male with a patch of long cilia in place of bulla (Papua New Guinea) ..... *B. aceraglans*

– Wing with a narrow infuscation over R-M and DM-Cu crossveins and intermediate portion of vein M; femora fulvous; male with bulla small and indistinct (Papua New Guinea) ..... *B. wanangiae* **sp. n.**

11 Apical third of mid femur black or black-spotted, mid tibia at least partly and hind tibia entirely dark fuscous to black; costal band broadened or expanded apically; male bulla blackened; scutum with lateral postsutural yellow vitta extending anterior to suture as a distinct spot; abdomen with medial black vitta across tergites III-V connected anteriorly with a broad transverse band across tergite III; anepisternal yellow stripe narrow, not reaching postpronotal lobe anteriorly 12

– All femora and tibiae fulvous except hind tibia often fuscous; costal band narrow, not or only weakly expanded apically; male bulla often not blackened; scutum with lateral postsutural yellow vitta often not extending anterior to suture as a distinct spot; abdomen with medial black vitta generally confined to tergites IV-V or V, seldom entering or crossing tergite III but not connected with a transverse band across it; anepisternal yellow stripe often broad and reaching postpronotal lobe anteriorly 13

12 Apical third of mid femur, most of mid and all of hind tibiae dark fuscous to black; costal band broadened apically and reaching vein M; scutum with the dark medial and submedial vittae not broadly connected posteriorly; a narrow presutural yellow vitta present between postpronotal lobe and sutural spot (southern Philippines: Tawi Tawi) ..... *B. peterseni*

– Apical third of mid femur with a black spot, basal third of mid and all of hind tibiae dark fuscous to black; costal band expanded into a distinct apical patch; scutum with the dark medial and submedial vittae broadly connected posteriorly; presutural yellow vitta absent (Southern Thailand, Peninsular Malaysia, Borneo, Sumatra and Java) ..... *B. bullifera*

13 Scutum with lateral postsutural yellow vitta normally extending anterior to suture as a distinct spot; presutural lateral yellow vitta present; lateral postsutural yellow vitta parallel-sided and enclosing intra-alar seta 14

– Scutum with lateral postsutural yellow vitta not extending anterior to suture as a distinct spot; presutural lateral yellow vitta absent, if present then reduced to a small yellowish patch immediately behind postpronotal lobe; lateral postsutural yellow vitta short and not enclosing intra-alar seta 16

14 Anepisternal yellow stripe narrow, only reaching anterior notopleural seta anteriorly; scutum with a broad black submedial vitta; presutural lateral yellow vitta broadly connecting presutural spot with postpronotal lobe; costal band pale and indistinct; male wing with a pale fuscous patch across vein M between R-M and DM-Cu crossveins (Papua New Guinea and Papua Province, eastern Indonesia) ..... *B. diaphana*

– Anepisternal yellow stripe broad, reaching postpronotal lobe anteriorly; scutum with or without a narrow black submedial vitta; presutural lateral yellow vitta not broadly connecting presutural spot with postpronotal lobe; costal band distinct; wing without a pale fuscous patch across vein M 15

15 Scutum with narrow dark submedial vitta and a narrow presutural lateral yellow vitta connecting or almost connecting postpronotal lobe with sutural spot; costal band reaching vein M (Philippines) ..... *B. mcgregori*

– Scutum without dark submedial vitta and with a broad presutural lateral yellow or orange vitta between postpronotal lobe and notopleuron; costal band not reaching vein M (Papua New Guinea) ..... *B. aceromata*

16 Anepisternal yellow stripe broad, reaching postpronotal lobe anteriorly; scutum red-brown; scutellum yellow with a narrow dark basal band ... 17

– Anepisternal yellow stripe narrow, not reaching postpronotal lobe anteriorly; scutum and scutellum largely orange-brown 19

17 Abdomen with black lateral markings; antennal first flagellomere apically truncate; male bulla large and ovate (Andaman and Nicobar Is, West Malaysia and Singapore) ..... *B. cinnabaria*

– Abdomen without black lateral markings; antennal first flagellomere apically rounded; male bulla small and rounded or possibly absent 18

18 Scutum with lateral postsutural yellow vitta sharply tapered posteriorly; notopleural lobe yellow; crossvein DM-Cu not enclosed by a narrow transverse fuscous band; small facial spots present; male bulla indistinct or absent; pecten of cilia on tergite III in males weak or absent; female unknown (Solomon Islands: Florida I.) ..... *B. unipunctata*

– Scutum with lateral postsutural yellow vitta slightly tapered posteriorly; notopleural lobe red-brown; crossvein DM-Cu enclosed by a narrow transverse fuscous band; facial spots absent; male bulla distinct; pecten of cilia on tergite III in males well developed; female aculeus apically trilobed (Papua New Guinea) ..... *B. trilobata* **sp. n.**

19 Scutum with a short, medial black vitta across line of suture; lateral postsutural yellow vitta sharply tapered posteriorly; scutellum with a narrow black lateral vitta; costal band not reaching vein M; male bulla small and round and placed on vein A_1+Cu_2 beyond apex of very narrow cell bcu extension; abdomen with a narrow, interrupted black medial vitta on tergites I-V and broader sublateral markings on tergites III-IV (males) or with a distinct black medial vitta and broad lateral margins on tergites III-V (females) (Western Samoa) ..... *B. aenigmatica*

– Scutum without a medial black vitta; lateral postsutural yellow vitta narrow but not distinctly tapered; scutellum yellow basolaterally; costal band reaching vein M; male bulla large and ovate and cell bcu extension vestigial; abdomen without lateral black bands and medial vitta confined to tergite V (Papua New Guinea and Solomon Islands, including Nendo) ..... *B. pacificae*

Discussion

Although not all *Bulladacus* species show all the diagnostic characters, their overall similarity suggests that the subgenus is monophyletic. The lack of

shining spots (ceromata) on abdominal tergite V and the presence of either a bulla or patch of cilia at or near the apex of wing cell bcu extension appear to be synapomorphies for the subgenus. *Bactrocera aceraglans* from Papua New Guinea and possibly *B. unipunctata* from Solomon Islands lack both the bulla and abdominal pecten in males but otherwise appear to belong here.

The geographical distribution of the 20 known *Bulladacus* species is shown in Table 1, placed within the six zones recognised by Hancock and Drew (2015). Two species (*B. penefurva* and *B. pacificae*) occur in both Papua New Guinea (Zone D) and the Solomon Islands (Zone F); all other species are endemic to their particular zones. The lack of *Bulladacus* species from Wallacea (Zone C) likely reflects undercollecting rather than a genuine absence.

Table 1. Distribution of species in genus *Bactrocera* and subgenus *Bulladacus* in each biogeographic zone and percent endemism in *Bulladacus*. For a map of zones A-F see Hancock and Drew (2015).

Biogeographic Zone	**No. species of *Bactrocera***	**No. species of *Bulladacus***	**% Endemic *Bulladacus***
(A) Indian subcontinent	75	0	–
(B) South-East Asia	225	5	100
(C) Wallacea	124	0	–
(D) New Guinea	170	10	80
(E) Australia	76	2	100
(F) South Pacific	59	5	60

The subgenus appears to be closely associated with *Gnetum gnemon*, a tropical shrub/tree distributed from NE India throughout much of SE Asia and Australasia (excluding mainland Australia) as far east as Fiji and Samoa. Some species, particularly the Australian *B. tigrina* and *B. flavinotus*, have become adapted to *Terminalia* species, while the Samoan *B. aenigmatica* utilises *Aglaia samoensis*. Although *Bulladacus* species might be expected to occur throughout the range of *Gnetum* species, so far they are only known as far west as southern peninsular Thailand and the Andaman Islands. Greatest diversity exists on the island of New Guinea, where ten species are known, suggesting that the subgenus arose there before dispersing westwards into SE Asia and eastwards into the South Pacific.

The three strongly sexually dimorphic species, *B. tigrina*, *B. penefurva* and *B. captiva*, occur in NE Australia, Papua New Guinea-Solomon Islands and the Philippines respectively, with the latter two species appearing to be the most closely allied morphologically. A similar faunal relationship between New Guinea and the Philippines exists in the closely related acanthonevrine genera *Copiolepis* Enderlein and *Piocolepis* Hancock (Hancock 2014). Of the

remaining SE Asian species, *B. bullifera* (Sundaland) and *B. peterseni* (Tawi Tawi) appear to be an allopatric species pair: both have dark areas on the mid femur and mid and hind tibiae, plus three dark scutal vittae, a complete dark medial vitta on abdominal tergites III-V, a narrow anepisternal yellow stripe that does not reach the postpronotal lobe, a broad apex to the costal band and an oval or rounded, distinctly blackened bulla. Likewise, *B. cinnabaria* (Sundaland) and *B. mcgregori* (Philippines) also appear to be an allopatric species pair: both are generally pale species with a broad anepisternal yellow stripe, a paler, ovate bulla and a short, apically truncate antennal first flagellomere especially in males. The presence or absence of a presutural lateral yellow vitta thus appears to be homoplasious, particularly since its alignment, when present, differs in the various species showing it.

In New Guinea, *B. aceraglans* (Western Highlands) stands alone, having largely fuscous femora, the bulla replaced by a patch of cilia and the pecten absent. Of the others, *B. wanangiae* (Madang and Morobe Provinces) shares with *B. aceraglans* the black scutum, while *B. diaphana* (West Sepik and Indonesian Papua) + *B. aceromata* (Central Province), both with a presutural lateral yellow vitta, and *B. bullata* (East Sepik) + *B. warisensis* (Indonesian Papua), both with the postsutural lateral yellow vitta extending anterior to the suture as a distinct spot, a black submedial scutal vitta, a dark wing band over at least DM-Cu crossvein, a small bulla at the apex of a relatively elongate cell bcu in males and an almost unpatterned abdomen, appear to be related pairs. The latter five species all have fulvous femora and all six species have a parallel-sided lateral postsutural yellow vitta that encloses the intra-alar seta. The medial postsutural yellow vitta in *B. bullata* is narrower than in other species showing this character and is presumably homoplasious, particularly since the other species lack the presutural spots.

The new species *B. trilobata* (Madang) has the lateral postsutural yellow vitta ending before the intra-alar seta and not extending anterior to the notopleural suture; it also has a red-brown scutum and fulvous femora and appears to be closest to *B. unipunctata* from the Solomon Islands. The *Terminalia* host plants, overall appearance, very short antennal first flagellomere (0.4 mm) and well developed supernumerary lobe of the male wing in *B. eximia* suggest a relationship with the *tigrina-penefurva-captiva* series.

The three South Pacific species *B. aenigmatica* (Samoa), *B. gnetum* (Fiji) and *B. pacificae* (Solomon Islands and Papua New Guinea) all have a short lateral postsutural yellow vitta and likely form a related series that possibly includes *B. unipunctata* and *B. trilobata*. In *B. gnetun* the scutum is black, the scutellum yellow, the anepisternal yellow stripe reaches the postpronotal lobe and the hind tibia is weakly fuscous. In *B. aenigmatica* and *B. pacificae* the scutum and scutellum are largely orange-brown, the anepisternal yellow stripe does not reach the postpronotal lobe and the hind tibia is dark fuscous, suggesting another allopatric species pair despite the differences in the bulla.

A similar faunal relationship between Fiji, Solomon Islands (particularly Nendo) and Western Samoa is seen in the adramine *Coelotrypes punctilabris* (Bezzi) (Hancock and Drew 2005).

The host plant switch from *Gnetum* to *Aglaia* in *B. aenigmatica* suggests that it reached Samoa prior to the arrival of *Gnetum*. The occurrence of an extended abdominal black vitta in both western and eastern outlying species suggests that this character, widespread in many *Bactrocera* species, is homoplasious and that the short vitta on tergites IV-V or V only, seen in most *Bulladacus* species, is the plesiomorphic state for the subgenus.

Relationships of the Australian *B. flavinotus*, with its red-brown scutum, rudimentary bulla and relatively weak supernumerary lobe, remain uncertain but its *Terminalia* host plant, very short antennal first flagellomere (0.4-0.44 mm) and broad medial postsutural vitta suggest a plesiomorphic relationship with the *eximia-captiva* series. As with *B. aenigmatica*, the host plant switch likely reflects the absence of *Gnetum* from Australia and suggests that the *flavinotus-captiva* series originated there. A more detailed analysis of phylogenertic relationships will be possible after all subgenera have been reviewed and the polarity of character states more accurately determined.

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THE STATUS OF *YOMA ALGINA* (BOISDUVAL, 1832) AND *Y. SABINA* (CRAMER, 1780) (LEPIDOPTERA: NYMPHALIDAE: NYMPHALINAE) IN AUSTRALIA

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Abstract

Yoma Doherty, 1886 (Nymphalinae: Junoniini) comprises two species, *Y. algina* (Boisduval, 1832) and *Y. sabina* (Cramer, 1780), which we confirm in this study by using larval morphology and colour pattern, pupal morphology, adult morphology (*i.e.* wing pattern elements, wing colour, fore and hindwing shapes, male genitalia) and host plant specialisation (*Y. algina* restricted to *Hemigraphis* spp: Acanthaceae). In total, we determine at least 22 phenotypic character state differences between the two species and, in addition, confirm that both species occur in Queensland. In Australia, *Y. sabina* occurs in the Top End of the Northern Territory, throughout Torres Strait and from eastern Queensland from Cape York to Townsville, while *Y. algina* is now confirmed to naturally occur in Queensland, currently known only on the east coast of Cape York Peninsula from Somerset at Cape York to Peach Creek, 25 km NNE of Coen. The subspecific status of Australian populations of *Y. algina*, tentatively assigned to *Y. a. netonia* Fruhstorfer, 1912, will remain in doubt until more Australian material is collected. Butterfly house populations of *Y. algina* in eastern Australia have existed since the late 1980s but were confused with *Y. sabina* for many years. These populations are thought to originate from a single female collected at Iron Range, Cape York Peninsula. Thus, the existence of *Y. algina* in Queensland has led to confusion in regards to the life history of *Y. sabina*. A review of *Y. s. sabina* from Papua New Guinea and *Y. s. parva* (Butler, 1876) from mainland Australia, including Torres Strait, indicates that the two taxa do not differ phenotypically. In addition, the original description of *Y. s. parva* was found to be based on a diminutive 'dry season form', which is atypical of normal *Y. sabina* from Australia. Thus, because of the phenotypic continuity of *Y. sabina* through Papua New Guinea into Australia and confusion with the nomenclature of the Australian population caused by Butler, we regard *Y. s. parva* syn. nov. as a junior synonym of *Y. s. sabina*. In addition, the diminutive 'dry season form' of *Y. s. sabina* occurring in Papua New Guinea and Australia is here proposed as form *parva* stat. rev.

Introduction

The genus *Yoma* Doherty, [1886] occurs widely in the Oriental and Australian Regions (d'Abrera 1978, Parsons 1998). *Yoma sabina* (Cramer, [1780]) is a lowland butterfly (Igarashi 1985), which has a broad distribution from Myanmar to Hong Kong in southern China, Taiwan, the Philippines, through Thailand to Indonesia, the Moluccas, mainland New Guinea and, within Australia, from Torres Strait into tropical mainland Queensland and the Northern Territory (Bingham 1905, Tsukada 1985, Parsons 1998, Bascombe *et al.* 1999, Braby 2000, Ek-Amnuay 2006). The type locality of *Y. sabina* is Ambon Island in the Moluccas, Indonesia (Edwards *et al.* 2001, Parsons 1998).

Yoma algina (Boisduval, 1832), which is considered to be a second species (d'Abrera 1978, Parsons 1998), in contrast is much more restricted in its distribution, occurring predominantly in the New Guinea region from Waigeo

Island through to the Solomon Archipelagos and Vanuatu (Parsons 1998, Tennent 2002). The type locality of *Y. algina* is 'New Guinea' (Parsons 1998) but is thought to be more precisely Waigeo Island in West Papua Province, Indonesia (Fruhstorfer 1912-15).

All of the recent major works on Australian butterflies (Common and Waterhouse 1972, 1981, Braby 2000, Orr and Kitching 2010) have the genus as monotypic and consisting of just one species, *Y. sabina*, with *Y. algina* a subspecies of *Y. sabina* occurring in New Guinea. Fruhstorfer (1912-1915), Barrett and Burns (1951), d'Abrera (1978) and Tennent (2002), however, considered the two taxa to be specifically distinct. This distinction was supported by Parsons (1998), who reported collecting both taxa in Papua New Guinea flying together at several locations, including Port Moresby. Thus he considered the two taxa to be separate species and sympatric in their occurrence, at least in some areas.

Both taxa are highly variable in their underside wing markings. Thus, Parsons (1998) suggested eight subspecies of *Y. algina* in Papua New Guinea, with *Y. a. netonia* Fruhstorfer, 1912 occurring in southern Papua New Guinea and *Y. s. sabina* occurring in New Guinea and the Moluccas (Tsukada 1985, Parsons 1998). In Australia, *Y. s. parva* (Butler, 1876) occurs in the Wet Tropics of Queensland, on Cape York Peninsula, on several Torres Strait islands and in localised areas in the Northern Territory (Braby 2000).

On mainland Queensland, *Y. s. parva* can be generally uncommon in the southern end of its range in the Wet Tropics but, further north, it is observed more frequently: at Cooktown (Valentine 1988) and particularly in Torres Strait (Braby 2000, T.A. Lambkin unpublished data), especially on Thursday Island (Valentine 1988). The species frequents lowland rainforest, open forest bordering rainforest (G. Sankowsky pers. comm.) and monsoon forest (Braby 2000). In addition, it is found in swampy areas (Valentine 1988) and in upland rainforests of the Atherton Tableland (Olive 1978). Overall, the species is mostly observed during or just after the wet season. Adult males fly along sunlit tracks defending territories and perch (Valentine 1988) with wings outspread, normally within 2-5 m from the ground (Braby 2016). Females of *Y. sabina* are often observed flying low over the forest floor in search of oviposition sites on or near low-growing herbaceous host plants (Saguru and Haruo 2000, Braby 2016). Adults are also found within the forest settled on the underside of foliage and, in these situations, are often difficult to detect due to their cryptic underside colouring. In addition, *Y. sabina* is known to aestivate in large numbers throughout the dry season in Cape York Peninsula and Townsville, clustering in dense vines, caves and old buildings (Sankowsky 2015, Braby 2016, P.S. Valentine pers. comm.).

Parsons (1998) and Tennent (2002) noted that adults of *Y. algina* frequently perch along sunlit tracks and clearings in rainforest habitats.

The life history of *Y. s. sabina* from Papua New Guinea was described by Szent-Ivany and Carver (1967) and Parsons (1998). From the Moluccas, Saguru and Haruo (2000) illustrated the egg and final instar of *Y. s. sabina*. In Australia, the life history of what was believed at the time to be *Y. s. parva* but found here to be that of *Y. algina* was described from material collected at Iron Range, Cape York Peninsula in Queensland (Wood 1987a).

Saguru and Haruo (2000) reported observing a female of *Y. s. sabina* ovipositing on the ground (in the Moluccas) and the egg was successfully reared to an adult on *Gendarussa vulgaris* Nees. (a synonym of *Justicia gendarussa* L.) (Acanthaceae). Additionally, Saguru and Haruo (2000) observed females of *Y. s. podium* Tsukada, 1985 in Taiwan, ovipositing on *Blechum pyramidatum* (Laam.) Urb. (Acanthaceae). Sankowsky (2015) added that larvae of *Y. s. parva* usually rest on the ground when not feeding.

There is little published on the early stages of *Y. algina* apart from a photograph of a larva, indicated to be instar 3, in Parsons (1998).

In Australia, Wood (1987a) successfully reared larvae of what he thought at the time to be *Y. s. parva* on what he believed to be a *Ruellia* sp. (now syn. of *Dipteracanthus* Nees) (Acanthaceae). Later, Sankowsky (1991) confirmed *D. bracteatus* (R.Br) (Acanthaceae) as a larval host plant for *Y. s. parva* at Iron Range.

In Papua New Guinea, Szent-Ivany and Carver (1967) reared *Y. s. sabina* on *Hemigraphis reptans* (G.Forst.) T. Anderson ex Hemsl. (Acanthaceae), while Parsons (1998) provided a detailed description of the early stages of *Y. s. sabina* but did not mention a larval host plant.

Yoma s. parva, until recently, was rarely encountered in the Wet Tropics of Queensland but of late it has been observed more frequently due to the widespread increase of its host plant (*Dipteracanthus* spp) in the area (J. Olive pers. comm.). In early 2004 it became established in Townsville (Valentine 2004, 2005), where it still occurs in 2016 (P.S. Valentine pers. comm.). The availability of *Y. s. parva* from near populated areas in recent years has made possible a closer examination of its life history, thereby enabling a better comparison with that of *Y. algina* reared in butterfly houses in eastern Australia.

Since the late 1980s, what was considered to be *Y. s. parva* has been reared in many butterfly houses along the east coast of Australia. The initial stimulus for the current study was in 2008, when one of us (RK) attempted to feed larvae of what was then thought to be a butterfly house population of *Y. s. parva* on *D. prostatus* (Poir.) Nees. [syn *R. prostata*]. This attempt was unsuccessful and puzzling since *Dipteracanthus* spp were the known larval hosts for *Y. s. parva* (Sankowsky 1991), yet none of the larvae would feed and all subsequently died. Consequently, this led to additional investigation of the two taxa.

Based on the current study, it is now apparent that these butterfly house populations of *Yoma* are not *Y. sabina* but are a separate species, *Y. algina*. This raised questions in regards to where in Australia the original culture material was derived or did it somehow originate from New Guinea stock. The exact origin of the original culture material that was used to commence these in-house butterfly populations is unknown but it is likely that it originated from a single female from Cape York Peninsula (G. Sankowsky pers. comm.). In addition, this current study of the life histories of both taxa has now indicated that the life history observations of Wood (1987a) were of *Y. algina*, not *Y. s. parva* as he supposed. Moreover, his larval host plant identification was also incorrect (Wood 1987a), as larvae of *Y. algina*, as reported here, are restricted to *Hemigraphis* spp and do not feed on *Dipteracanthus* spp (syn *Ruellia* spp).

As a result of an investigation of both taxa, described in this paper, *viz.* wing pattern elements, species' distributions, larval host plant preferences, immature stage morphologies and structures of male genital armature, we confirm that there are two species of *Yoma* and that both species naturally occur on mainland Australia. We also remove the confusion surrounding the immature stages of both species by describing and illustrating the life history of both in full for the first time. Thus, we unravel the confusion that has surrounded these two species in Australia since the 1980s and further revise the taxonomic status of *Y. sabina* in Australia.

Materials and methods

Rearing of immature stages and comparison of larvae and pupae

The immature stages of *Y. s. parva* were reared from eggs supplied ex wild-caught females collected from the Wet Tropics, Queensland. Those of *Y. algina* were reared from eggs supplied by the Melbourne Zoo ex butterfly house population. Eggs of both species were reared to instar 3 in clear plastic, round food containers (280 ml; 50 mm high, bottom radius 42 mm, top radius 55 mm) on the following plant material: *Y. s. parva* on *D. prostatus*, *H. alternata* (Burm.f.) T. Anderson and *H. ciliata* S. Moore, and *Y. algina* on the two *Hemigraphis* spp.

Larger larvae (instars 4 and 5) were later transferred to potted host plants in mesh cages (840 high x 480 x 400 cm). Larvae pupated beneath leaves or stems of the host plants, on the overhangs of pot plants, or on the ceilings of mesh cages. All life history studies were conducted in Brisbane during February and March at ambient conditions (*i.e.* max/min temperatures of approximately 32/22°C). Each instar of both species was described, measured and photographed. To determine any differences between the larvae and pupae of the two species, final instar larvae and pupae of *Y. s. parva* (n = 24) and *Y. algina* (n = 18) were compared.

Comparison of wing pattern elements among adults

To determine the extent of phenotypic variation between the two species, wing pattern, including colours and spotting, plus wing shape, were subjectively compared among 78 specimens of *Y. s. parva* (42♂♂, 36♀♀) from Queensland, 16 specimens of *Y. s. parva* (5♂♂, 11♀♀) from the Northern Territory, 29 specimens of *Y. s. sabina* (21♂♂, 8♀♀) from Papua New Guinea; 18 specimens of *Y. algina* (8♂♂, 10♀♀) ex butterfly house culture, 10 specimens of *Y. algina* (6♂♂, 4♀♀) wild caught in Queensland and eight specimens of *Y. a. netonia* (6♂♂, 2♀♀) from Papua New Guinea.

Request for data from butterfly collections

Commencing in 2009, requests with attached figures of both taxa were disseminated throughout the butterfly collecting fraternity (n = 8) and public museums (n = 4) for information concerning *Yoma* specimens in their possession. In brief, the requests carried images of both species, male and female, and the recipients were requested to use wing pattern elements and wing shape to discern if *Y. algina* existed in any of their collections (the specifics of this request are provided in Appendix I).

Comparison of male genitalia

The genital armature of three males of each taxon (*i.e.* 2♂♂ from Australia and 1♂ from Papua New Guinea) were dissected from the abdomens and prepared for examination. Each abdomen was treated with 10% (w/v) aqueous potassium hydroxide (KOH) for 24 hours at room temperature, similar to the method used by Braby (2000). Clarified genitalia were then stored in glycerol and examined unmounted using a stereomicroscope. From these examinations the genital armature of a representative of each taxon was chosen and photographed, then structural comparisons were made between the two taxa. Male genitalia examined of *Y. s. parva* were from Malanda and Thursday Island, Queensland; those of *Y. s. sabina* were from Kapa Kapa, Central Province, Papua New Guinea; and those of *Y. algina* were from the Melbourne Zoo Butterfly House (2♂♂). In addition, male genitalia were examined of one *Y. a. netonia* from Rigo, Central Province, Papua New Guinea. Nomenclature of genital structures follows Braby (2000) and Monastyrskii (2011).

Abbreviations

Repositories of material examined: AM – Australian Museum, Sydney; ANIC – Australian National Insect Collection, Canberra; CGMC – Collection of C.G. Miller, Lennox Head; GRFC – Collection of G.R. Forbes, Brisbane; HUC – Collection in Harvard University, Cambridge, MA, USA; MV – Museum of Victoria, Melbourne; QM – Queensland Museum, Brisbane; TLIKC – Joint collection of T.A. Lambkin and A.I. Knight, Brisbane; WJC – Collection of W. Jenkinson, Beaudesert.

Names on labels: AA – A. Atkins; AIK – A.I. Knight; CGM – C.G. Miller; CWM – C.W. McCubbin; EDE – E.D. Edwards; EM – E. Mann; GAW – G.A. Waterhouse; GBM – G.B. Monteith; GD – G. Daniels; GD&MAS – G. Daniels and M.A. Schneider; GRF – G.R. Forbes; GW – G. Wurtz; HR – H. Rauber; JAK – J.A. Kershaw; IFBC&MSU – I.F.B. Common and M.S. Upton; JCLS – J.C. Le Souef; JFD – J.F. Donaldson; JO – J. Olive; JWCD – J.W.C. D'Apice; LR – L. Radunz; MDB – M. De Baar; MSM&BJM – M.S. Moulds and B.J. Moulds; OBL – O.B. Lower; PZ – P. Zborowski; RGE – R.G. Eastwood; TAL – T.A. Lambkin; TAW&IDN – T.A. Weir and I.D. Naumann; THG – T.H. Guthrie; WBB – W.B. Barnard; WJ&DB – W. Jenkinson and D. Bell; WJ&RKP – W. Jenkinson and R.K. Poulier.

Material examined

Yoma sabina parva (Butler, 1876)

QUEENSLAND: 1♀, Bamaga, Cape York, 28.iii.1964, IFBC&MSU (ANIC); 1♂, Batavia Downs, Cape York Peninsula, 13-19.i.1993, PZ (ANIC); 1♀, Cairns, captive bred Indooroopilly, Brisbane, 30.xii.2008, TAL (TLIKC); 1♀, same data except AA185; 1♂, Cape York, (QM); 1♂, same data except (ANIC); 1♀, Cape York, 19.x.1927, WBB (QM); 1♂, 1♀, Captain Billy Creek road junction, Cape York Peninsula, 11°41'S 142°42'E, 15.iii.1992, GD&MAS (QM); 1♂, Claudie River, 25.v.1974, JWCD (ANIC); 1♂, Chillagoe, OBL (QM); 1♀, Coen, Cape York Peninsula, 9-16.vii.1971, GBM (QM); 2♂♂, Cooktown, 20.iv.1922 (ANIC); 2♂♂, 2♀♀, same data except 2.viii.1979 (2♂♂), 7.vii.1964 (♀), 8.vii.1964 (♀), JCLS (ANIC); 2♂♂, 2♀♀, 35 km NW of Cooktown, 7.v.2003, WJ&DB (WJC); 1♂, Dauan Island, Torres Strait, 18.i.2004, TAL (TLIKC); 1♂, same data except 11.ii.2015 (TLIKC); 1♂, 2♀♀, same data except 12.ii.2015; 1♀, Gordon Creek area, Iron Range, Cape York Peninsula, 1.vii.1982, GD (QM); 3♂♂, 2♀♀, Green Hill, Thursday Island, Torres Strait, 23-31.vii.1983, TAL (TLIKC); 1♂, 1♀, same data except 20.ii.1994; 3♂♂, 1♀, same data except 24.ii.1994; 1♂, 1♀, same data except 24.iii.1994; 1♀, same data except 9.iii.2001; 1♀, same data except 3.iii.2004, AIK; 1♀, same data except 27-29.iii.1987, MDB; 1♂, Heathlands, Cape York Peninsula, 16.iii.1992, GD&MAS (QM); 1♂, Iron Range NP, Cape York Peninsula, 27.v.2010, WJ&RKP (WJC); 1♂, same data except, 26.v.-8.vi.??, JWCD (ANIC); 1♀, same data except 18-31.viii.1999; 1♀, same data except 4-12.vii.1995; 1♂, same data except 13.iv.1971, AA; 1♂, same data except -viii.1968, THG; 1♂, 1♀, Malanda, captive bred Indooroopilly, Brisbane, 30.xii.2009, TAL (TLIKC); 1♀, same data except AA180; 1♀, same data except AA178, em. 1.v.2010; 1♀, Mer Island, Torres Strait, 1.vi.1985, JFD (TLIKC); 1♀, same data except 30.ii.1986, MDB (TLIKC); 1♂, same data except 30.ii.1986, MDB (TLIKC); 1♀, same data except 9.iii.1995, TAL; 1♂, same data except 8-14.v.1998, JWCD (ANIC); 1♀, same data except 25.iv-5.v.1999, AIK (TLIKC); 1♂, same data except 25.i.2011, TAL&AIK; 1♂, same data except 28.i.2011, TAL&AIK; 1♂, same data except 29.i.2011, TAL&AIK; 1♀, same data except 9°54'S 144°02'E, 9.ii.2015, TAL&AIK; 3♂♂, Mt Cook NP, Cooktown, 12.x.1980, EDE (ANIC); 2♂♂, Mt Webb NP, -.ix.1980, EDE (ANIC); 1♀, Port Stewart Rd, Cape York Peninsula, 3.v.2003, WJ&DB (WJC); 1♀, Red Cliff, Cairns, 28.v.1973, JWCD (ANIC); 2♂♂, Somerset, 10.iv.1906 (ANIC); 1♂, 1♀, Thursday Island, 5.vi.1969, CWM (ANIC); 1♀, Trinity Park, N of Cairns, 1.xii.2009, ex captive ♀, JO (TLIKC).

NORTHERN TERRITORY: 5♂♂, 10♀♀, Rocky Bay, Gove, 3-7.v.1992, JWCD (ANIC); 1 ♀, Nhulunbuy, NT, Aug-Sept 1984, GW (ANIC).

Yoma sabina sabina (Cramer, [1780])

PAPUA NEW GUINEA: 2♂♂, Brown River, near Port Moresby, 9°15'S 147°05'E, 2.ii.1969, 15.ix.1975, HR (QM); 1♂, Kwikila, Central Province, 19.ii.1976, GRF (GRFC); 1♂, Rigo, PNG, 17.x.1968, GRF (GRFC); 4♂♂, 5♀♀, Kapa Kapa, Central Province, 9°48'S 147°31'E, 20.xi.1967 (♀), 14.xi.1968 (♀), 21.xi.1968 (♂), 26.xii.1968 (♀), 2.ii.1969 (♂), 6.ii.1969 (♂, 2♀♀), 23.xi.1973 (♂), HR (QM); 6♂♂, same data except 4.viii.1968 (♂), 10.viii.1968 (♂), 11.viii.1968 (2♂♂); 3.ii.1969 (2♂♂), 6.ii.1969 (3♂♂), GRF (GRFC); 4♂♂, same data except, 16.iv.1973 GRF (GRFC); 1♀, Kapa Gese, Central Province, PNG, 19.ii.1976, GRF (GRFC); 1♀, Kwikila, Central Province, 19.ii.1976, GRF (GRFC); 1♂,1♀, Paga Hill, Port Moresby, 18.i.1966, ex pupa, EM (QM); 1♂, same data except 19.i.1966; 1♂, Port Moresby, PNG, 3.ii.1971, GRF (GRFC).

Yoma algina (Boisduval, 1832)

QUEENSLAND: 1♂, 1♀, Claudie River, JAK (AM); 1♂, Heathlands, Cape York Peninsula, 11°45'S 142°35'E 15-26.i.1992, TAW&IDN (ANIC); 1♀, Iron Range, Cape York Peninsula, 1-9.vi.1971, GBM (QM); 1♂, 1♀, Iron Range, 25.v.1973 (♂), 28.v.1973 (♀), CGM (CGMC); 1♂, bred as *Y. sabina*, MDB, labelled 'ex breeding stock supposed to originate from Iron Range Qld, set Nov. 1990, original stock probably PNG' (TLIKC); 1♀, Lockerbie Area, Cape York Peninsula, 13-27.iv.1973, GBM (QM); 1♀, captive bred, ex. Melbourne Zoo colony, em. 21.xi.2009, TAL, Host *Hemigraphis* (TLIKC); 4♂♂, 9♀♀, same data except, em. 1.xii.2009 (2♀♀), 21.xii.2009 (1♂, 1♀), 22.xii.2009 (2♂♂, 2♀♀), 23.xii.2009 (1♂), 8.vi.2010 (1♀), 10.vi.2010 (1♀), 10.xi.2010 (1♀), 23.xii.2010 (1♀); 1♂, same data except AA168; 1♂, same data except AA1176; 1♂, same data except 30.iv.2010, AA170; 1♂, same data except 1.v.2010, AA171; 1♂, Peach Creek, 25 km NNE of Coen, 2.xi.1979, MSM&BJM (AM); 1♂, Philip Hill, Iron Range, 10.i.1994 RGE (HUC); 1♂, Somerset, Cape York Peninsula, Lep 11424, 10. iv. 1906, 'doubtfully Australian, GAW' (MV).

Yoma algina netonia Fruhstorfer, 1912

PAPUA NEW GUINEA: 1♂, Bulolo, Morobe Province, 20.i.1970, LR (QM); 1♂, Gabensis, Morobe Province, 7.vii.1973, GRF (GRFC); 1♂, Kapa Kapa, Kokoda Track, Central Province, 15.iv.1968, HR (QM); 2♀♀, Laloki, Central Province, 18.ii.1976, GRF (GRFC); 1♂, Rigo, Central Province, 15.x.1968, GRF (GRFC); 1♂, same data except 16.x.1968; 1♂, Wau, Morobe Province, 26.iii.1978, GRF (GRFC).

Results

Larval host plants

Larvae of *Y. s. parva* would not feed on *Hemigraphis* spp when young but when larger readily accepted this host. All larvae of *Y. algina* fed freely on *Hemigraphis* spp but refused to feed on *D. prostatus*. Thus, the results indicated larvae of *Y. algina* to be host specific to several species of just *Hemigraphis* and furthermore these larvae would not accept *Dipteracanthus* spp. In addition, larvae of *Y. s. parva* differed greatly from those of *Y. algina*

in that they readily accepted *D. prostatus* and only as large larvae accepted *H. alternata* and *H. ciliata*.

Life histories

Yoma sabina parva (ex Malanda and Trinity Park)

Egg (Fig. 1): (n = *ca* 40); dome shaped; smooth with 14 vertical ribs.

First instar larva (Fig. 2): (n = *ca* 40); head shiny black, covered in pale olive-green setae, with two short blunt black horns; body cylindrical, dorsal surface black, ventral surface with last abdominal and anal segment yellow-green and semi-translucent; mesothorax, metathorax and abdominal segments each with six branched spines with bristles, with the lateral basal spine and another single bristle below each spiracle; prolegs yellow-green, legs black.

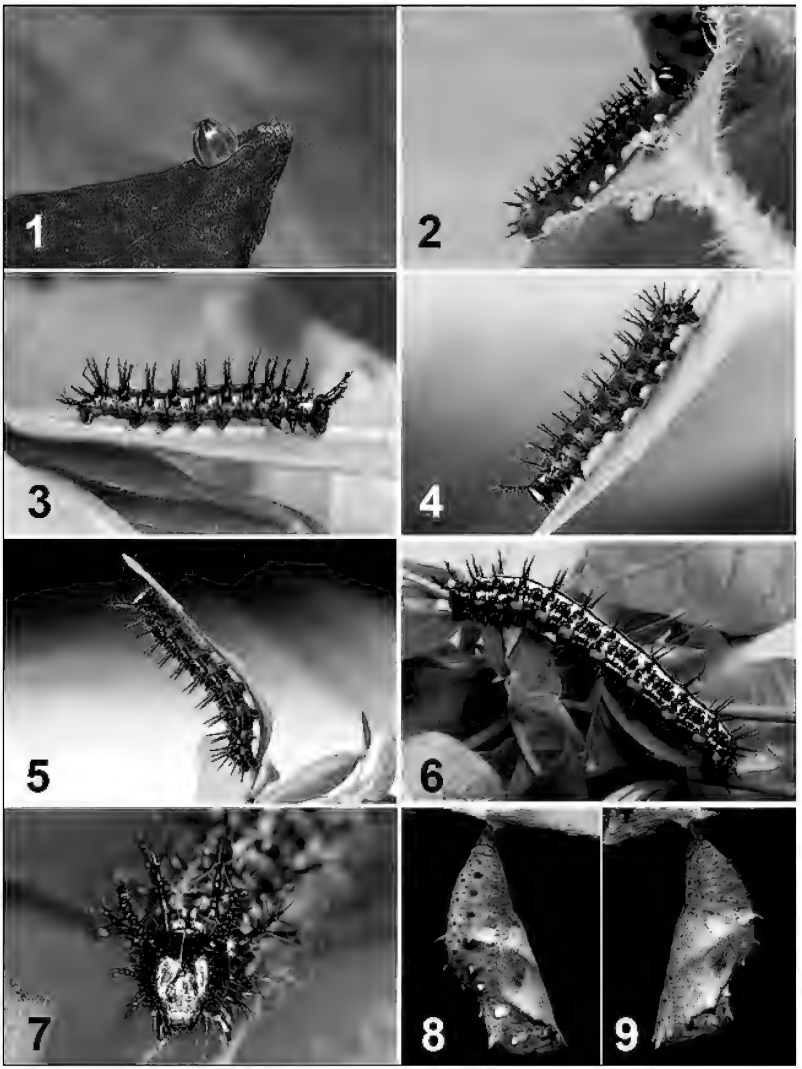
Second instar larva (Fig. 3): (n = *ca* 40); head as in first instar except setae black and horns longer; body as in first instar, shiny black with branched spines longer, with basal lateral spine originating from a circular bright orange patch; prolegs and legs black.

Third instar larva (Fig. 4): (n = *ca* 30); similar to second instar except spines longer and more branched, body with ventral bristly setae, a faint white lateral line joining orange patches and a pair of faint dorsal parallel white stripes running the full length of the body.

Fourth instar larva (Fig. 5): (n = 24); similar to third instar except body covered with many bristly setae, a definite white lateral line intermittently running the length of the body just above the setae, a faint lateral orange line joining orange patches and dorsally a defined pair of white parallel stripes running the length of the body.

Fifth instar larva (Fig. 6): (n = 24); similar to fourth instar except pair of spiny horns on head longer than the basal width between the two horns (Fig. 7); body black, smooth with noticeable white blotches forming two indefinite parallel lateral white lines and two indefinite parallel dorsal white lines, these dorsal white lines creating a noticeable dorsal black stripe between them; dorsal and lateral surfaces of body densely covered with fine white setae; dorsal black spines with a blue lustre with bases of spines blue.

Pupa (Figs 8-9): (n = 24); mottled brown and grey; anterior end with two projections; mesothorax with a sharp 90° dorsal ridge, two sharp lateral projections on edge of each wing case; with metathorax and abdominal segments possessing pairs of blunt spines; those spines on metathorax and abdominal segments 1 and 2 white; the largest spines being on abdominal segments 3 and 4, with pairs of large black and very small white blunt spines on abdominal segment 3, those on remaining abdominal segments blunt and black.



Figs 1-9. Early stages of *Yoma sabina*, Malanda, Qld: (1) egg (height 1 mm); (2) 1st instar larva (length 7 mm); (3) 2nd instar larva (10 mm); (4) 3rd instar larva (18 mm); (5) 4th instar larva (40 mm); (6) 5th instar larva (45 mm); (7) 5th instar larval head capsule (5 mm wide); (8-9) pupa, lateral views (height 25 mm).

Yoma algina (ex Melbourne Zoo Butterfly House)

Egg (Fig. 10): (n = circa 50); dome shaped; smooth with 14 vertical ribs.

First instar larva (Fig. 11): (n = 18); head shiny black, covered in cream-coloured setae, with two short blunt black horns; body cylindrical, dorsal and ventral surfaces black, with ventral surface, last abdominal and anal segment orange and semi-translucent; mesothorax, metathorax and abdominal segments each with six branched spines with bristles, with the lateral basal spine and another single bristle below each spiracle; prolegs orange, legs black.

Second instar larva (Fig.12): (n = 18); head as in first instar except setae black and horns longer; body shiny black with branched spines much longer than instar 1, with basal lateral spine originating from a circular dark orange patch; prolegs brown and legs black.

Third instar larva (Fig. 13): (n = 18); similar to second instar except spines on body longer and more branched; body glabrous, with bristly setae on ventral surface and a pronounced white lateral line joining orange patches; prolegs brown with bases black.

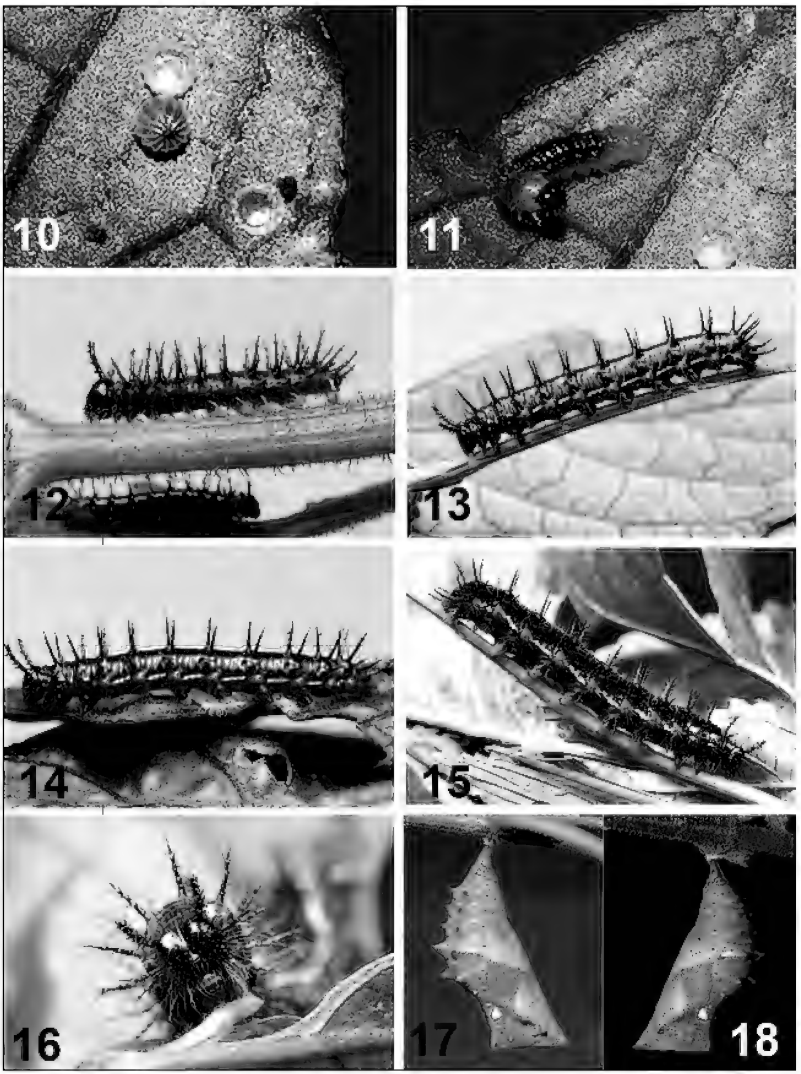
Fourth instar larva (Fig. 14): (n = 18); similar to third instar with white lateral line more pronounced.

Fifth instar larva (Fig. 15): (n = 18); similar to fourth instar except pair of spiny horns on head as long as the basal width between the two horns (Fig. 16), body non-glabrous with dorsal and lateral surfaces densely covered with fine white setae and bases of dorsal spines with a faint blue spot; body with a pronounced cream-coloured lateral line.

Pupa (Figs 17-18): (n = 18); mottled brown; anterior end with two projections; mesothorax with a sharp 90° dorsal ridge, two sharp lateral projections on edge of each wing case; metathorax and abdominal segments possessing pairs of sharp spines; those spines on metathorax (being large) and abdominal segments 1 and 2 white; the largest spines being on abdominal segments 3 and 4, with pairs of large brown and very small brown sharp spines on abdominal segment 3; those on remaining abdominal segments brown, sharp and curved upwards.

Comparison of larvae and pupae

The most notable differences between final instar larvae of the two species are the positions of white or cream lines on the thoracic and abdominal segments (Figs 6, 15): final instar larvae of *Y. s. parva* bear two ill-defined parallel dorsal white lines (Fig. 6), while those of *Y. algina* bear a pronounced cream-coloured lateral line (Fig. 15). In addition, final instar larvae of *Y. s. parva* are overall paler in colour, bear fewer setae and are more glabrous in body appearance than those of *Y. algina*, which appear darker, bear more setae and have a more hirsuite body texture.



Figs 10-18. Early stages of *Yoma algina*, Melbourne Zoo culture: (10) egg (height 1 mm); (11) 1st instar larva (length 6 mm); (12) 2nd instar larva (9 mm); (13) 3rd instar larva (20 mm); (14) 4th instar larva (30 mm); (15) 5th instar larva (45 mm); (16) 5th instar larval head capsule (6 mm wide); (17-18) pupa lateral views (height 24 mm).

The younger instars (2, 3 and 4) of both species were also found to have distinctive morphological differences (Figs 3-5, 12-14).

The final instar head capsules of both species are covered in facial setae and bear two black horns. The *Y. algina* head capsule (Fig. 16) has more facial setae than *Y. s. parva* (Fig. 7) and the horns of *Y. algina* (Fig. 16) are thicker than those of *Y. s. parva* (Fig. 7).

The pupae of the two species are notably different in the pattern of thoracic and abdominal spines, with pupae of *Y. algina* bearing much heavier and longer spines (Figs 17-18) than those of *Y. s. parva* (Figs 8- 9). The pupae of both species vary in colour, ranging from brown to dark grey, each with white blotches.

Overall, our descriptions and illustrations of the immature stages of *Y. s. parva* matched the illustrations of *Y. s. sabina* provided by Saguru and Haruo (2000).

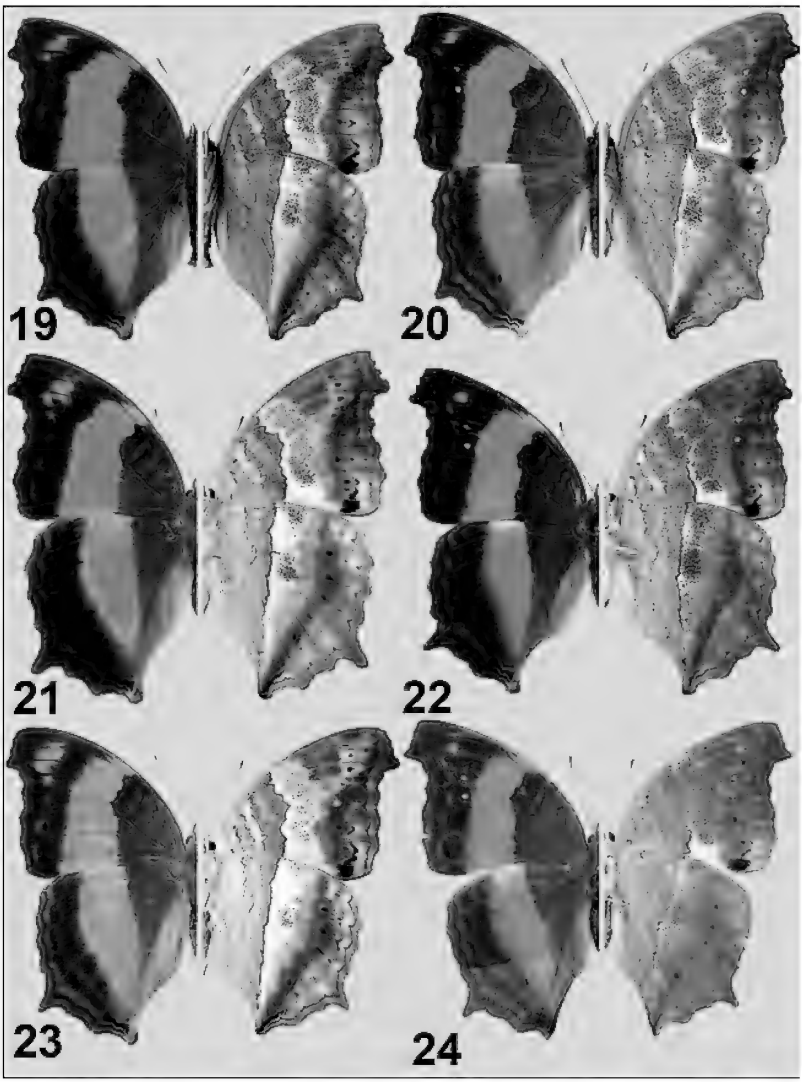
Comparison of wing pattern elements

Superficially, adults of the two *Yoma* species (Figs 19-32) resemble each other but individuals can be readily separated using several wing pattern elements. Thus, the upperside orange colour of both sexes of *Y. algina* is much brighter and more vibrant (Figs 27-30, 32) than that of *Y. s. parva* (Figs 19-26, 31). Specifically for females, there are two orange spots in the subapical forewing area of *Y. s. parva* (Figs 20, 22, 24-26), while the same spots in *Y. algina* are white (Figs 28, 30, 32). Additionally, in females the hindwing uppersides of *Y. algina* always bear distinct ocelli in the orange submarginal areas (Figs 28, 30, 32).

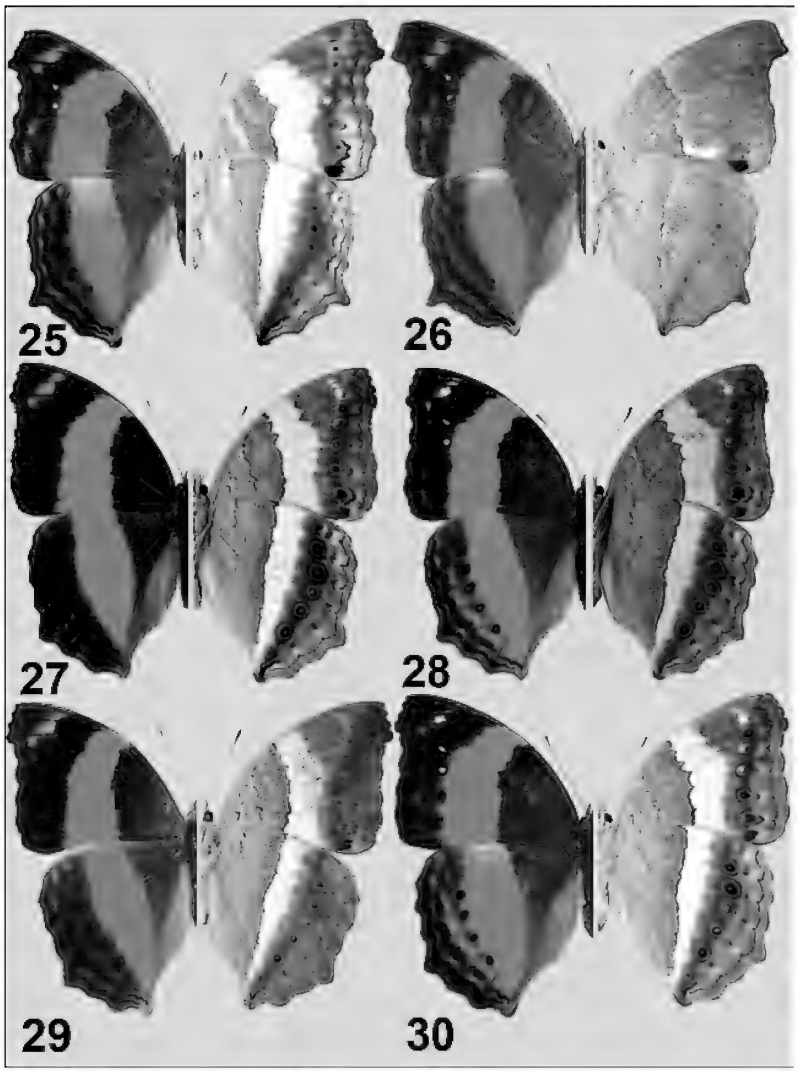
On the underside, the wing patterns of *Y. s. parva* are much more variable than those of *Y. algina*, with *Y. s. parva* possessing submarginal black spots (Fig 19-26) rather than distinct ocelli in the same wing areas of *Y. algina* (Figs 27-30). Moreover, both sexes of *Y. algina* always possess a broad underside white band (Figs 27-30).

The shape of the forewing apex of both species differs, being pronounced and falcate in *Y. s. parva* (Figs 19-26, 31) and only slightly projected in *Y. algina* (Figs 27-30, 32). This is also the case for the short and blunt terminal tail on the hindwing, that of *Y. s. parva* being relatively long but almost absent in *Y. algina*.

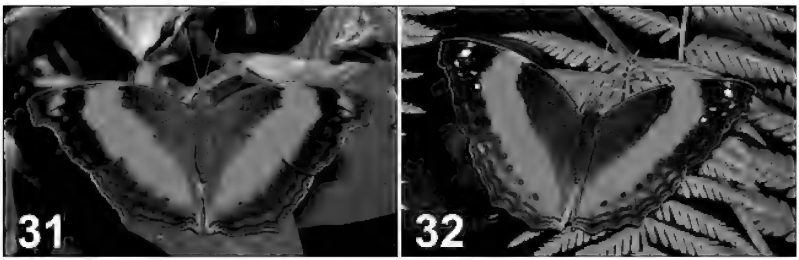
Finally, based on the review of 29 specimens (21♂♂, 8♀♀) of *Y. s. sabina* from Papua New Guinea and 94 specimens (47♂♂, 47♀♀) of *Y. s. parva* from Australia, plus their variability in general, we found no consistent upperside wing pattern elements that can be used to confidently separate the two subspecies. In addition, the underside wing patterns of both populations are so highly variable that no differentiation between the two populations could be made using wing underside patterns.



Figs 19-24. *Yoma sabina* (all figures not to scale, upperside left, underside right). (19, 21, 23) ♂♂: (19) Malanda, Qld, 30.xii.2009, TAL [forewing length 38 mm]; (21) Dauar Island, Torres Strait, Qld, 12.ii.2015, TAL [42 mm]; (23) Mer Island, Torres Strait, 25.i.2011 TAL&AIK [41 mm]. (20, 22, 24) ♀♀: (20) Malanda, Qld, 30.xii.2009, TAL [42 mm]; (22) Dauar Island, 12.ii.2015, TAL [39 mm]; (24) Mer Island, 30.ii.1986, MDB [38 mm].



Figs 25-30. *Yoma* spp (all figures not to scale, upperside left, underside right). (25-26) *Yoma sabina* ♀♀: (25) Cairns, Qld, 30.xii.2008, TAL [forewing length 42 mm]; (26) Green Hill, Thursday Island, Torres Strait, 20.ii.1994, TAL [36 mm]. (27-30) *Yoma algina*: (27) ♂, ex Melbourne Zoo colony, em. 22.xii.2009, TAL [35 mm]; (28) ♀, ex Melbourne Zoo colony, em. 10.xi.2010, TAL [39 mm]; (29) ♂, Iron Range, Qld, 1990, MDB [35 mm]; (30) ♀, ex Melbourne Zoo colony, em. 22.xii.2009, TAL [38 mm].



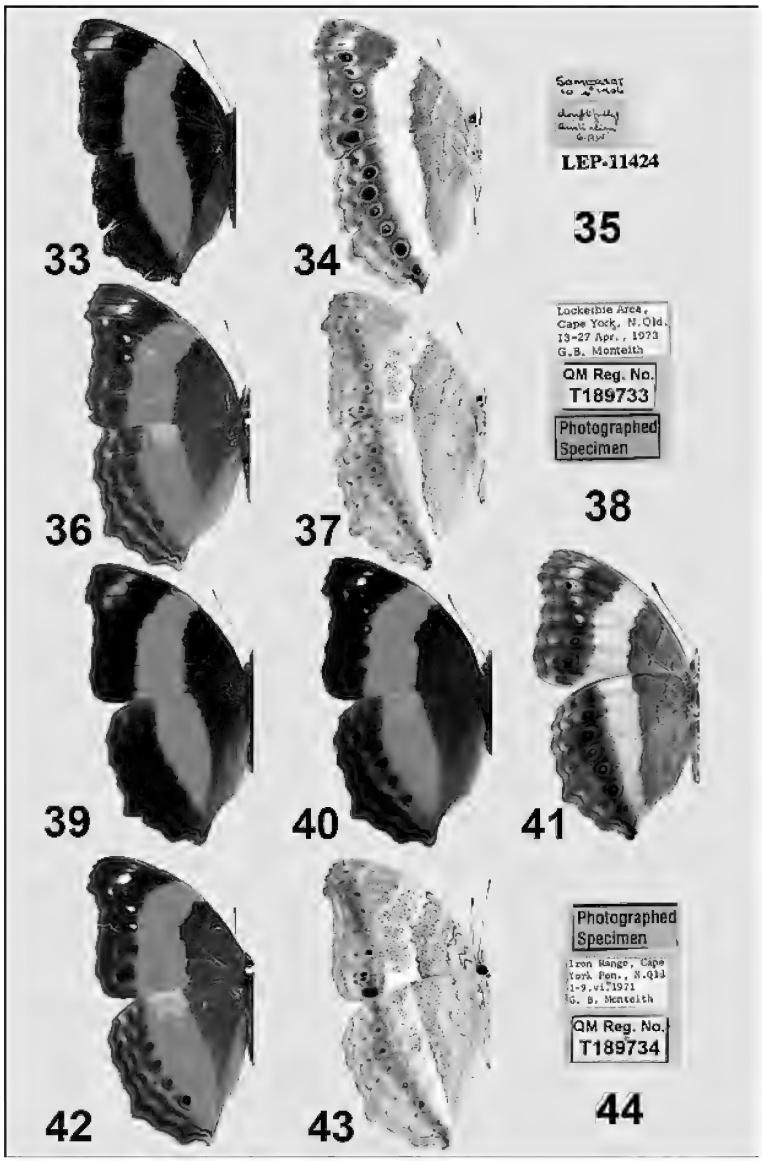
Figs 31-32. Live adults of *Yoma* spp in captivity in typical perched positions on forest edges (figures not to scale): (31) *Y. sabina* ♂ [forewing length 42 mm]; (32) *Y. algina* ♀ [40 mm]. (Photographs courtesy of G. Sankowsky, Tolga).

Request for data from butterfly collections

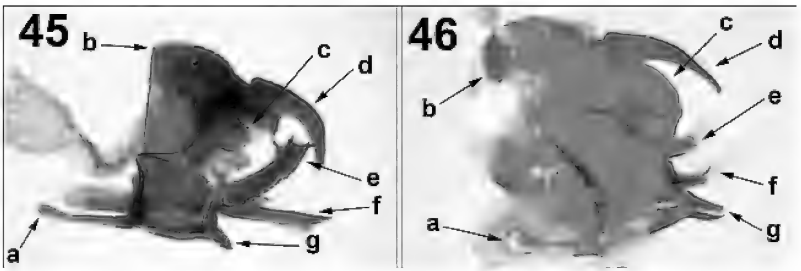
The request for collection data from institutional (4 out of 4 responded) and private collections (7 out of 8 responded) produced 10 specimens (in three institutional and two private collections) of wild caught *Y. algina* (6 ♂♂, 4 ♀♀), all from Cape York Peninsula, Queensland (Figs 33-44). The collection data further indicated that the specimens all originated from the east coast of Cape York Peninsula, *i.e.* extending north from Peach Creek Crossing near Coen, through Claudie River, Iron Range and Heathlands, to Somerset and Lockerbie at Cape York. Over half the specimens (6) originated from the Claudie River basin (Figs 39-44) and the earliest known specimen was collected in 1906 at Somerset (Figs 33-35, in MV). All five locations contain tracts of rainforest or semi-deciduous monsoonal vine thicket. Other wild caught specimens not illustrated are: ♂, ♀, Claudie R, 1914 (AM); ♂, Peach Ck, 25 km NNE of Coen, 1979 (AM); ♂, Heathlands, 1992 (ANIC); ♂, Philip Hill, Iron Range, 1994 (HUC).

Comparison of male genital armature

The male genital armature (Figs 45-46) of the two species are markedly different, with just about all structures distinctly dissimilar. Most notable are: the relatively small claspers (valvae) of *Y. algina*; the relatively very thin apical tip of the phallus (aedeagus) of *Y. s. parva*; the unique structure of the gnathos of each species is very diagnostic, that of *Y. algina* being very large with spines; although the unci in both species are hook-shaped, the uncus of *Y. algina* is much more so. There are also noticeable differences in the shapes of the tegumen, vinculum and saccus of each species. Aside from these differences, Parsons (1998) reiterated the comment by Fruhstorfer (1912-1915) on the general complexity of the structures of the male genitalia of *Yoma* spp. This study certainly found the same, particularly the complicated structure of the clasper, uncus and gnathos (Figs 45-46: c, d and e respectively).



Figs 33-44. Some of the wild caught Australian specimens of *Yoma algina* with their origins (all Cape York Peninsula) and repositories: (33-35) ♂, Somerset, 1906 (MV); (36-38) ♀, Lockerbie, 1973 (QM); (39-41) ♂, ♀, Iron Range, 1973 (CGMC); (42-44) ♀, Iron Range, 1971 (QM); forewing lengths of specimens were not recorded.



Figs 45-46. Male genital armature, lateral left view, dorsal surface uppermost: (45) *Yoma algina*, ex Melbourne Zoo culture, captive bred Indooroopilly, Brisbane, Qld, 10.vi.2010, TAL, host *Hemigraphis* (TLIKC); (46) *Yoma sabina*, Green Hill, Thursday Island, Torres Strait, 3.iii.2004, AIK (TLIKC). Approximate widths of genitalia including saccus = 5 mm; names of structures labelled are: a – saccus, b – tegumen, c – clasper, d – uncus, e – gnathos and f – phallus.

Discussion

In the early 1980s, a stock of *Y. algina* (believed at the time to be *Y. s. parva*) was used to commence a commercial butterfly house culture of *Yoma*. Despite the adults of both species being similar in their wing pattern elements, the individuals of *Y. algina* flying in the butterfly houses appeared, in general, to be much brighter in appearance than *Y. s. parva*, with a more intense and vibrant orange colouration on the upperside of the wings, particularly in the males. Because very few individuals of *Y. s. parva* had been reared at that time, it was thought that the brightness of individuals reared in butterfly houses was perhaps related to the fresh colour of newly eclosed individuals.

The question remains, where did the butterfly house culture stock of *Y. algina* originate? When first identified, this species was not known from Australia and it was presumed that livestock originated from Papua New Guinea. Initial discussions with several collectors and butterfly workers suggested that the *Yoma* culture first established in the Melbourne Zoo Butterfly House came from live material collected either from Iron Range by G. Wood (as per Wood 1987a), or from Weipa by the late Charles McCubbin who, just prior to his death in 2010, told one of us (RK) that he collected live *Yoma* females from Weipa for the Melbourne Zoo in the early 1990s, not long after the zoo established its butterfly house, although *Yoma* is still unrecorded from Weipa (Braby 2000, 2016). G. Sankowsky (pers. comm.) rejected the latter claim and stated that Graham Wood, who was working at Iron Range in the 1980s, sent him a gravid female and resulting progeny were supplied to the Australian Butterfly Sanctuary at Kuranda, Queensland and, subsequently, to the Melbourne Zoo in the late 1980s. Based on this latter information, the most plausible scenario is that Melbourne Zoo's *Y. algina* most likely originated from Iron Range, Cape York Peninsula, in the late 1980s.

The review of *Yoma* specimens in public and private collections indicated that, in Australia, *Y. algina* occurs sympatrically with *Y. s. parva* exclusively in eastern Cape York Peninsula, roughly from McIlwrath Range (*i.e.* Peach Creek Crossing) near Coen, north to the tip of Cape York Peninsula (*i.e.* Somerset). The distributions of the two species are also known to overlap in southern Papua New Guinea (Parsons 1998). The true taxonomic identity of this isolated Australian population of *Y. algina* will remain uncertain until a more thorough revision is made, particularly of material from New Guinea and until more wild-caught Australian specimens become available. The Australian population is tentatively assigned here to the southern Papua New Guinean subspecies *Y. a. netonia* (Parsons 1998), based solely on the geographical proximity of eastern Cape York Peninsula to southern Papua New Guinea.

The introduction of *Y. a. netonia* from Iron Range into the butterfly houses in eastern Australia added a degree of misunderstanding in the literature, particularly with the life history and identification of *Y. s. parva*. Wood (1987a) was confused with the host plants that he used to rear what he thought at the time to be *Y. s. parva*. He illustrated, in monochrome, a final instar larva that he identified as *Y. s. parva*, but which clearly matches the mature larva of what we now know to be *Y. a. netonia*. A similar mistake, this time in identifying the adults, was perpetuated by several authors who illustrated *Y. a. netonia* instead of *Y. s. parva* in their publications on Australian butterflies (*viz.* Valentine 1988, Braby 2000, 2004, 2016, Orr and Kitching 2010).

Currently, the immature stages of *Y. a. netonia* have not been found in the wild in Australia but, based on our host plant preference experiments, *Hemigraphis* appears to be the preferred host plant. Based on records from G. Sankowsky (pers. comm.) and Australia's Virtual Herbarium (2016), *H. ciliata* appears to be the sole native Australian species of *Hemigraphis* occurring in Queensland. Current records indicate that *H. ciliata* is restricted to the eastern side of Cape York Peninsula, mostly from the Pascoe River to the Rocky River in damp shady areas in very well developed rainforest, although there are a few records of it further south around Cape Tribulation. These distribution records, albeit in all probability incomplete, correlate roughly with the known distribution of *Y. a. netonia* in Queensland. If *H. ciliata* is the native host, then *Y. a. netonia* might also occur further south around Cape Tribulation in the Wet Tropics.

Hemigraphis alternata is a naturalised species thought to originate in Java, Indonesia. Australia's Virtual Herbarium (2016) records indicate that it is currently known from tropical Queensland, between Port Douglas and Cooktown and near Almaden. Other *Hemigraphis* spp in cultivation in Queensland include *H. reptans* (Roth) J.R.J. Wood from the Pacific Islands and *H. urens* from India. A cultivated *Hemigraphis* sp. is reported to be

common in gardens and council plantings in the wet tropical lowlands of northern Queensland (G. Sankowsky pers. comm.).

Several native *Dipteracanthus* spp are recorded from tropical Australia (Australia's Virtual Herbarium 2016), including *D. australasicus* F. Muell. from much of tropical Australia and *D. bracteatus* from tropical Queensland north of Cairns, the Top End of the Northern Territory and in Torres Strait. The distribution of *D. bracteatus* roughly matches that of *Y. s. parva*. In addition, G. Sankowsky (pers. comm.) has reared *Y. s. parva* on *Brunoniella australis* (Cav.) Bremek (Acanthaceae), which occurs widely throughout eastern Australia and the Northern Territory (Australia's Virtual Herbarium 2016) and therefore could be a natural host plant of *Y. s. parva* in the Queensland tropics, including Iron Range. Braby (2016) recorded *B. spiciflora* (F.Muell. ex Benth.) Bremek as a host of *Hypolimnas alimena lamina* Fruhstorfer, 1903 (Nymphalinae: Junoniini) in Australia.

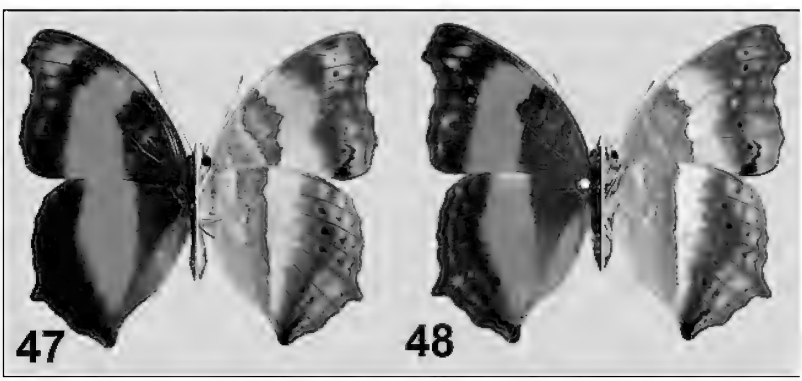
Based on his knowledge of *Yoma* in Cape York Peninsula, G. Sankowsky (pers. comm.) further indicated that, in the wild, the two *Yoma* spp are separated by disparate ecotones: *Y. s. parva* generally occurs in a variety of habitats from more open forest to lowland rainforest (Valentine 1988) where *D. bracteatus* and *B. australasicus* grow, while *Y. a. netonia* is restricted to rainforest where *H. ciliata* grows.

Although *Y. s. parva* is well known from mainland Australia (Braby 2000, 2016), much less is known of its distribution throughout Torres Strait, where the species appears to be confined to islands with stands of semi-deciduous monsoon or vine forest. These islands include: in the south of the strait, Thursday (Waiben) (Waterhouse and Lyell 1914, Lambkin and Knight 1983, De Baar 1988, Valentine 1988), Horn (Ngurupai) (unpublished data, T.A. Lambkin: December 1993, January 1994), Prince of Wales (Muralug) (Waterhouse and Lyell 1914) and Hammond (Keriri) (unpublished data, T.A. Lambkin: April 1989); in the central region, Moa (Waterhouse and Lyell 1914, Valentine and Johnson 1993); in the east, Darnley (Erub) (Waterhouse and Lyell 1914, Johnson 1983), Murray (Mer) (Waterhouse and Lyell 1914, Wood 1987b, Lambkin and Knight 1990) and its neighbouring island Dauar (TLIKC); and Dauan Island (TLIKC) in the north. A useful map indicating the positions of these islands and others in Torres Strait is illustrated in Braby (2000: p. 17).

In this study, evidence from several data sources, *i.e.* larval colour pattern, morphology and host plant requirements, pupal morphology, adult wing shape, colour pattern elements and male genitalia, support a specific distinction between the two taxa, based on the principles of the species concept (de Queiroz 2007). Although the two species are similar in their biology and biotype requirements and share some sympatry in their geographical distributions, our investigations identified at least 22 phenotypic character states that the two taxa do not share.

Six character states were found in the final instar larvae that differentiated the two species: the pattern and position of cream-coloured lines on, and the basal colour and texture of, the thoracic and abdominal segments; the degree of thoracic and abdominal setae; and, on the head, differences in the degree of facial setae and thickness of the horns. There was at least one character state that differentiated the pupae, with the thoracic and abdominal spines of *Y. a. netonia* being heavier and longer that those of *Y. s. parva*. Differences in wing pattern elements (*i.e.* colour, pattern arrangement and shape) between the two taxa were notable, with seven character states that differed between the two species. The male genitalia of the two taxa are dissimilar in the shape and size of the claspers, phallus, gnathos, uncus, tegumen, vinculum and saccus (seven character state differences). Finally, *Y. a. netonia* appears to be host specific to *Hemigraphis* spp (another character state difference).

This study also highlighted the similarity of the nominate subspecies of *Y. sabina* to the Australian taxon *Y. s. parva*. Both taxa meet at a theoretical line situated on the southern coast of Papua New Guinea: to the north of this line is *Y. s. sabina* while to the south is *Y. s. parva*. We questioned the basis of this separation during our study of *Y. sabina* from Australia and Papua New Guinea. Thus, our review of the description of *Y. s. parva* by Butler (1876) has revealed that his description (as *Rhinopalpa parva*) was based, in all probability, on a single male specimen (Edwards *et al.* 2001) collected at Cape York by Rev. J.S. MacFarlane. More interestingly, Butler's (1876) description matches the wing pattern elements of a phenotypically distinct, diminutive 'dry season form' referred to by Waterhouse and Lyell (1914) (Figs 47-48). This form is typically observed just after the commencement of the first rains of the monsoonal wet season.



Figs 47-48. *Yoma sabina sabina* form *parva* (figures to scale, upperside left, underside right): (47) ♂, Dauar Island, Torres Strait, Qld, 12.ii.2015, TAL [forewing length 30 mm]; (48) ♀, Dauar Island, Torres Strait, Qld, 11.ii.2015, TAL [forewing length 34 mm].

It is obvious now that Butler (1876) had before him a specimen of this form, even remarking at the end of his description that 'This is the smallest *Rhinopalpa* that I have seen' and based his description of *parva* on this specimen, not on what is the more typical 'wet season' *Y. sabina* that occurs in Australia and Papua New Guinea (Figs 19-26). Being smaller in size is one of the key characters of the 'dry season form', having more orange in the sub-marginal areas of the forewing upperside and, in the male, possessing a distinctive tawny spot in the upperside forewing cell, all features that Butler (1876) described. This diminutive form is now known from both Papua New Guinea (Parsons 1998) and Australia (Braby 2000).

Thus, our study validates Fruhstorfer (1912-1915), Barrett and Burns (1951), Parsons (1998) and Tennent (2002) in their treatment of the two taxa as distinct species and, moreover, confirms the natural occurrence of *Y. a. netonia* on mainland Queensland. Based on the known distributions of the larval hosts in Cape York Peninsula and beyond into the Wet Tropics and possibly Torres Strait, the distribution of *Y. a. netonia* may be more extensive than current collection records indicate.

In addition, the staggered distribution of *Y. s. parva* across Torres Strait is likely an artefact of butterfly collecting efforts on specific islands, with some inhabited islands with suitable habitats still not surveyed well for butterflies. Thus, *Y. s. parva* in Torres Strait is also probably more widespread than presently known and this distribution is almost certainly related to the distribution of its larval host plants (*Dipteracanthis* spp and possibly *Brunoniella* spp).

Furthermore, based on our review of *Y. sabina* from Papua New Guinea and Australia, it was found that the two populations differed little phenotypically and, accordingly, we regard the subspecies *Y. s. parva* (Butler, 1876), **syn. nov.** as a junior synonym of *Y. s. sabina*. Provisionally, until a proper revision of the 'dry season form' is undertaken, we also propose this diminutive 'dry season' form as *Y. s. sabina* form *parva* **stat. rev.**

Finally, further intensive collecting of *Yoma* spp may reveal the presence of *Y. a. netonia* in areas such as the western side of Cape York Peninsula, in the Wet Tropics and in the southern Torres Strait, in particular on the southern islands of Prince of Wales and Hammond. These two islands have extensive areas of suitable habitat and have been visited relatively infrequently by butterfly workers.

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Appendix I

Specifics of the request for data from butterfly collections to ascertain the existence of wild caught specimens of Australian *Y. algina*:

'A recent examination of several purported Australian specimens indicates that two species of *Yoma* could occur in Australia, *viz. Y. sabina* and *Y. algina*. *Yoma algina* is predominately a New Guinean species and superficially resembles *Y. sabina*. In general, the underside wing pattern of *Y. algina* is less variable than *sabina*; the orange colouring of the *algina* male is brighter than *sabina*; the forewings of *algina* are less falcate and in the underside submarginal areas *algina* has ocelli instead of the black dots of *sabina*. Specifically, in the females, *algina* has submarginal ocelli on the upperside hindwings, and the apical markings of the forewing upperside are white instead of orange as in the female of *sabina*. To help elucidate this issue and confirm if *Y. algina* naturally occurs in Australia, we would appreciate receiving collection data of *Yoma* spp, together with an identification based on the attached figures that show wing pattern differences between the two species and as outlined above.'

EUREMA BLANDA SARAHA (FRUHSTORFER) (LEPIDOPTERA: PIERIDAE: COLIADINAE) REDISCOVERED IN TORRES STRAIT, QUEENSLAND, AUSTRALIA

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Abstract

A female *Eurema blanda saraha* (Fruhstorfer, 1912) was collected on Dauan Island on 9 March 2016 and represents the first record from Torres Strait, Queensland, since 1909.

Introduction

Braby (2010) stated that *Eurema blanda* (Boisduval, 1836) is known, within Australian limits, only from Christmas Island (Indian Ocean) and Darnley Island in eastern Torres Strait. The record for the latter locality was based on a single male originally in the Australian Museum, reputedly collected by H. Elgner on 20 December 1909. The reliability of Elgner's record was in doubt, however, since the species had not been encountered for over 100 years, despite extensive surveys throughout the islands.

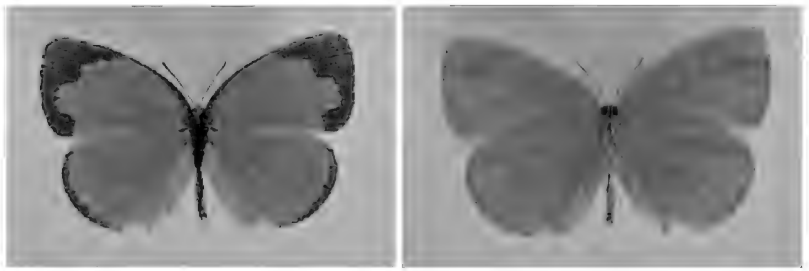
The original record was provisionally referred to subspecies *E. blanda indecisa* (Butler, 1898) by Waterhouse and Lyell (1914) and Waterhouse (1932) but subsequently replaced by *E blanda saraha* (Fruhstorfer, 1912), the mainland New Guinea subspecies, in the first and revised editions of Common and Waterhouse (1972, 1981) and in Braby (2000). In Papua New Guinea, *E. blanda saraha* is widespread throughout the mainland and may be common to abundant (Parsons 1998).

During a visit to Dauan Island in early March 2016, a single female of *E. blanda* was collected on 9 March, feeding on flowers in monsoonal vine scrub. The significantly larger size initially distinguished it from the very abundant *E. hecabe* (Linnaeus, 1758).

Discussion

Eurema blanda resembles *E. hecabe* and *E. alitha* (C. & R. Felder, 1862) but is distinguished by the sex brand in the males, the shape of the black marginal bands on the upperside of each wing, the presence of three brown dots in the cell of the forewing underside and the larger size compared with other Australian *Eurema* Hübner, 1819 species (Common and Waterhouse 1981, Parsons 1998).

The Dauan Island female of *E. blanda* (Figs 1-2) has the broad black marginal band at the apex with the inner margin less sharply indented at vein M_3 when compared with that of *E. hecabe* and *E. alitha*. The marginal band on the hindwing upperside of the Dauan Island specimen is narrow and not distinctly scalloped. The wingspan of 46 mm is consistent with that of *E. blanda saraha* from Papua New Guinea (female 50 mm) (Parsons 1998).



Figs 1-2. *Eurema blanda saraha* female from Dauan Island, Torres Strait, Queensland: (1) upperside; (2) underside.

Braby (2000) described seasonal variation in many of the Australian *Eurema* species, with the 'summer form' often having faint or occasionally absent markings on the underside of both wings, while the 'winter form' usually has more prominent markings. The specimen from Dauan Island lacks brown spos on the underside of the wings and is consistent with the 'summer form' of other *Eurema* species. It also lacks the three spots in the cell of the forewing underside that are typical of *E. blanda*; however, these cell spots may be reduced or absent in some 'forms' of *E. blanda* (*http://www.boldsystems.org/index.php/Taxbrowser_ Taxonpage?taxid=104436*).

Parsons (1998) listed *Caesalpinia bonduc* (L.) Roxb. and various *Cassia* species (both Fabaceae: Caesalpiniodeae) as food plants. These plant species occur on Dauan Island, with *Caesalpinia* being reasonably abundant on the beach ridges along the northern and eastern sides of the island. Parsons (1998) also stated that females are known to lay eggs in very large batches of over 100 on the underside of the leaves of the food plants. However, no early stages of the species were observed.

The Dauan Island female is identified as *E. blanda saraha* as it meets the descriptions in Common and Waterhouse (1981) and Parsons (1998) and is consistent with the female *E. blanda saraha* (Fig. 3) from Papua New Guinea illustrated in Braby (2016). This specimen is the first recorded female from Queensland and the first recorded from Torres Strait since 1909.

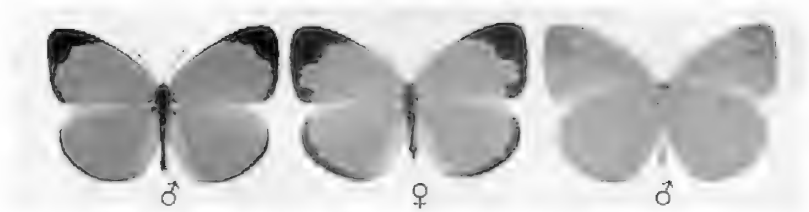


Fig. 3. *Eurema blanda saraha* from Papua New Guinea (reproduced from Braby 2016, with permission).

Further observations and specimens are required to determine whether the species is vagrant or established on Dauan Island. The abundant *E. hecabe* may have contributed to the lack of confirmed observations previously; however, the distinctly larger size of *E. blanda* compared with other *Eurema* species, particularly *E. hecabe* and *E. alitha*, is an important distinguishing attribute.

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MISCELLANEOUS NOTES

The following note is abstracted from the *News Bulletin of the Entomological Society of Queensland* and appeared, with illustrations, in the Volume and Part indicated.

Acraea terpsicore (Linnaeus) (Lepidoptera: Nymphalidae). – The Tawny Coster is now well established in the Kowanyama area on the Gulf of Carpentaria, Queensland and represents a significant range extension from the recorded range in the Northern Territory. It was first recorded in the Darwin area of the Northern Territory in April 2012 and had spread to Kakadu National Park, east Arnhem Land and near Kalumburu in the Kimberley [Western Australia] by mid 2013 (Braby *et al.* 2014).

A recent field trip from 8-19 August 2016 to the lower Mitchell River catchment, including Dunbar Station, Rutland Plains Station, Koolatah Station and the community lands of Kowanyama, revealed that the Tawny Coster was abundant throughout the area. Records range from very common (20 individuals/hour) at the Mitchell River crossing at Dunbar Station, very common (20/half hour) feeding on *Melaleuca* flowers at a creek crossing 2.7 km NNE of Koolatah Station, uncommon (4 in 6 hrs) on Rutland Plains Station from the homestead to 30 km south on the Nassau River, and common (20 in 5 hrs) on Kowanyama community land from the coast 22 km west of the town to 30 km NE of it.

The very rapid expansion of the range of *A. terpsicore* from the Northern Territory to Queensland over a very short period indicates that further expansion is likely throughout Cape York Peninsula and the Gulf of Carpentaria (if not already there) to the east coast over the next couple of years.

Reference: Braby, M.F., Thistleton, B.M. and Neal, M.J. 2014. Host plants, biology and distribution of *Acraea terpsicore* (Linnaeus, 1758) (Lepidoptera: Nymphalidae): a new butterfly for northern Australia with potential invasive status. *Austral Entomology* **53**: 288-297.

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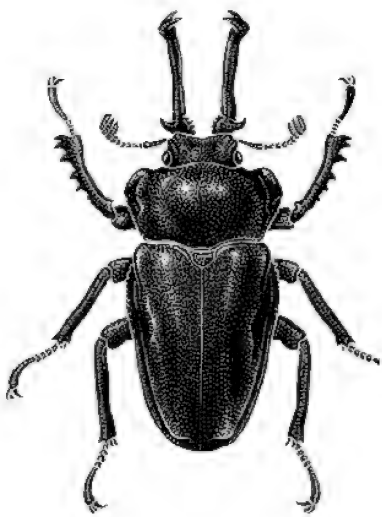

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